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Civil Engineering

QUALITY ASSESSMENT OF DIFFERENT SOIL TYPES FOR IMPLEMENT OF SHALLOW FOUNDATION

Mohammed Abbas MAALA

Master’s Thesis

Supervisor

Prof. Dr. Tuncer ÇELİK

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The thesis titled “QUALITY ASSESSMENT OF DIFFERENT SOIL TYPES FOR IMPLEMENT OF SHALLOW FOUNDATION” prepared by MOHAMMED ABBAS MAALA and submitted on 06/12/2022 has been **accepted unanimously** for the degree of Master of Science in Civil Engineering.

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I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Mohammed Abbas MAALA

Signature

DEDICATION

I dedicate this thesis to God Almighty my creator, my strong pillar, and my source of inspiration, wisdom, knowledge, and understanding. He has been the source of my strength throughout this program. This work is also dedicated to those with whose consent the Lord is pleased, my parents. Especially heaven's scent, (my mom) who has continuously prayed for me unconditionally, and my father who taught me to work hard for the things I aspire to achieve. To my eternal love (my wife), who encouraged me, supported me, and endured me throughout this period. my brothers, who have been a constant source of support and encouragement during the master's program. to Assist. Prof. Sohaib Al-Mamoori, I am genuinely thankful for your instructions. To my children Ola, Ali, and Haya who have been affected in every way possible by this quest. Thank you. My love for you all can never be quantified.

ABSTRACT

QUALITY ASSESSMENT OF DIFFERENT SOIL TYPES FOR IMPLEMENT OF SHALLOW FOUNDATION

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The failure of soil segment under shallow wall foundations was considered in the study pathway to analyze the chance of soil failure under these types of foundation. The study investigated the cases of failure by using the general bearing capacity equation of soil at first step. The equation based on number of variables depending o the type and the physical properties of the soil. The friction angle as well as the cohesion magnitude of the soil is found in the equation body in which these terms influenced the bearing capacity for the design purpose. The study took the impact of each part of the equation including the shape factors, depth factors, and bearing capacity factors. The study examined the influence of water table when the level of it been above the contact elevation between the foundation and the soil. Number of curve fitting processes was implemented in the study to figure out the effect of each parameter o the final bearing capacity resultants as can cover much number of soils. The impact of the parameters then collected until the bearing capacity equation was derived to improve the final results with less steps. The curve fitting output was in linear polynomial, and exponential form. The final equation reached was:

qu=Fq P1+Fqd P2+P3 Each term of the derived equation can be calculated simply based on the main parameters of the soil and the foundation that impact the bearing status. The simulation of cases was done by using ANSYS work bench program. The properties of the soil and the applied weight of foundation were drawn inside the program. The study showed the transition of stresses from the foundation toward the deepest level of soil in inclined angle.

Keywords: Soil Types, Shallow Foundation, Soil Quality

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ABBREVIATIONS

RSF	:	Reinforced Soil Foundation
GW	:	Gravel Well granulated
GC	:	Gravel is well granulated with clay binder
GU	:	Gravel of Uniform composition
GP	:	Gravel Poorly granulated
GF	:	Gravel with a lot of Fine particles
SW	:	Sand Well granulated
SC	:	Sand is well granulated with Clay binder
SU	:	Sand of Uniform composition
SP	:	Sand Poorly granulated
SF	:	Sand with a lot of Fine particles
CL	:	Clay of Low plasticity
OL	:	Organic clay of Low plasticity
OH	:	Organic clay of High plasticity
CH	:	Clay of high plasticity

LIST OF SYMBOLS

MI : Dust (silt) of medium plasticity

c' : $cohesion\ of\ soil$

γ : $unit\ weight\ of\ soil$

qu : ultimate bearing capacity of soil

:

:

1. INTRODUCTION

1.1 INTRODUCTION

All civil engineering structures, such as houses, dams, and bridges, are built on soils. A foundation is required to carry the load of the structure over a vast region of soil. The structure's basis should be designed so that the soil below somehow doesn't fail in shear and the framework does not plunge excessively. The notion of bearing capacity underpins the usual procedure of base design. Soil distorts when it is stressed because of loading. Moisture content, concentration, angle of contact force, then the condition in which load is placed beyond the soil all impact a soil's resilience to distortion. The biggest weight per unit of area that what a rock and soil can suffer deprived of yielding as well as movement is raised to as soil weight carrying of the capacity [1]. The carrying capacity of a soil is influenced by soil factors including such shear, porosity, permeation, and so on. So because concentration of dense sand is greater than that of loose sand, it will have larger quantity bearing capacity than sand. If the load carrying capacity of particular soil at shallow depth seems to be sufficient to safely support the structure's load, a non-deep foundation is posited. Shallow foundations can be built with isolated footings, integrated footings, or strip footings [2]. Pile foundation is employed when the soil directly beneath the structure is insufficiently bearing. Piles, pilings, or a well can be used to construct deep foundations. Mat or raft underpinnings are appropriate for soil with differential settling or when there is a significant difference in loading between adjacent columns[3]. Bearing capacity is the ability of soil to help in the support of weights applied to the land above. It is mostly determined by the kind of soil, shear strength, and density. It also depends on the depth of embedment in which the load is embedded - the deeper it is founded, the larger the bearing capacity. Where there is insufficient bearing capacity, the ground can be upgraded or the loading spread over a larger area such that the applied force to the specific soil is lowered to an acceptable magnitude smaller than the bearing capacity. Spread foundations made of reinforced concrete can be used to get there [4]. The ultimate load of a foundation implies the highest load that the foundation soils can withstand, and its reasonable determination is one of the most important factors in foundation design. Many studies on the final load capacity of footings above saturated soils have been conducted. In any case, because of the widespread use of waterproofing and drainage systems, foundation soils are mainly unsaturated above ground[5].

Understanding foundation designs and soil types is essential for anyone planning to build or expand their home. The cost of construction foundations is one of the most significant aspects, therefore anyone who wants to maintain control over their budget and schedule should determine the best base system to use as soon as feasible. The most cost-effective raveling result will be determined mostly by the ground conditions on site, such as the type of soil, aggregate, or rock and its major ingredients The easiest way to accomplish this prior to beginning work on the field is to commission a geotechnical investigation, which entails digging or boring trial holes around the planned new construction site, primarily to begin the load bearing capacity of the soil at various depths [6].

1.2 THE SIGNIFICANCE OF SOILS IN CONSTRUCTION PROJECTS

Access to good specialized soil is critical for the construction of new infrastructure. Soil is used directly to manufacture construction materials such as cement and brick, and it is also used indirectly to cultivate the grounds required to make building materials such as wood boards and insulation fibers. Historically, many dwellings and other structures were built with soil or specific soil that had been caked and dried of blocks [7]. There are numerous significant engineering considerations that must be made when creating safe construction, bridges, and other structures. The following route discovery properties characterize better soil for making reference facilities [8]:

a. Proper composition and pH, so that construction materials really aren't corroded.

b. Stability during wet and dry cycles, preventing expanding soil from cracking roadways or foundations.

c. Tensile strength, ensuring that the mass of the structure does not end up causing this to sink into to the ground.

d. Capability to collect rainfall so that erosion and precipitation need not cause damage.

The physical shape qualities of soil are related to its strength and stability. Good-structured soil is more stable. Even though clay materials have much more benefit structure than sand textures, they are often more stable; however, a wide range of particles size (and pore size distribution) is beneficial for creating. Not all product contains are created equal. A few clays, including such betonies, shrink and expand more than others during drying and wetting cycles. Whenever the soil characteristics are unsuitable for development, there really are techniques and actions that can be used to alter the scenery and provide good building sites[9]. Drainage could be constructed or land masses altered to direct liquid away from the site, for example. Recognizing a site's properties of soil is critical in order to incorporate remedial action into to the layout as well as avoid potential failures. There really are countless well-known historical examples of workers failing to adequately understand their soil, causing structural disasters. Aside from trying to regulate drainage, tamping and sustaining this same specific soil before building may have lowered settling issues. A leaning construction or a fractured basis may appear difficult, but a lack of soils information could result in catastrophic building status failures. Eroding soil particles flying in a large body of water for example can be abrasive to bridges, eventually destroying the structural strength and causing the tower to collapse. Homes built on steep earth's surface with particular soil that loses power when wet are prone to being carried away only with eroding hillside all through high specific soil water periods[10].

1.3 MECHANISMS OF SOIL FAILURE

Soil deformations could be investigated in order to design and build safe structures. It can implement deterrent and corrective measures once we've identified the failure modes. If the foundation fails to do its function, it may see various fractures in the walls. Doors and windows stick and are difficult to open. Another concerning indicator of foundation troubles is the separation of chimneys from the house exterior. The presence of all of these signals indicates that the soil's carrying capability is less than the loading [11].

1.3.1 Foundation Failure Causes

Among the many causes of foundation failure, the most common are given below

a. Soil type beneath the base (expansive soils)

b. The soil has a low density.

c. Soil eroding over the course of a structure's life span

d. Plants suffer as a result of a decrease in soil moisture.

e. Soil creep or unexpected landslides

f. Mechanisms of soil failure[11]

1.4 PROBLEM STATEMENT

The construction projects supporting by the type of soil under the foundation. The problem of soils can weak the overall project and leading to collapsing in worse cases. Buildings that lay on shallow foundation like the residential small buildings can have the problem of soil failure in bearing capacity and other failure types. Non-sufficient analyzing of the soil strength can impact in negative way the stability of the buildings. The designer must deal with the actual soil layer that found in project site to be used as it or replaced it if no chance for resisting the calculated building loads leading to more cost to be consider.

1.5 CONTRIBUTION

The study examined the effective function of various types of soil with the available bearing capacity for resist the loadings in the case of shallow foundation. The study aimed to build strategical analysis and modeling for each soil type to make more precise figurative view for designer to deal with these situations. The study tried to build effective way in analysis by linking the statistical analysis with the theory of design.

1.6 OBJECTIVE

a. Classifying common types of soils and specifying the properties for each soil type like the cohesion and the friction angle in suitable tables.

b. Analysis the stability of the soils under various shapes of foundations by using the parameters as variables including the foundation dimensions and the applied vertical loads.

c. Collecting the data then feed them inside SPSS statistical analysis program for evaluating the function of each soil in applicable analysis.

d. Simulating the soil structure using ANSYS workbench program.

2. LITERATURE REVIEW

2.1 OVERVIEW

Typically, the selection of which foundation type to use for a given construction is regulated by a variety of characteristics such as specific soil type, historical field usage, nearby building, size of upgrade process, and constraints. Among these considerations, soil types play a vital impact, which is why this study discusses the selection of foundation as a base for various types of soil [12]. Because of the quantity of water it can retain, peaty soil often is dark brown or black in color and easily compact. In any particular instance, it gets extremely dry during the summer and could possibly face a fire hazard. It is a poor subsoil and therefore is unsuitable for support because foundations are the most steady above ground and don't shift or start changing structure[13]. Clay stores water well because it is made up of micro particles. However, due to its strong affinity for water, it expands significantly when wet and contracts significantly when dry. Once clay is slightly damp, it becomes extremely malleable, allowing it to be easily moved and tricked[14]. These drastic differences put tremendous strain on foundational principles, having caused them to shift upward and downward and eventually crack, rendering clay an inappropriate soil for support.[15]. Sand/Gravel is different types of soil, it has the major particles. It finishes dry as well as gritty to a contact as well as, due to the numerous perforations, does not hold moisture while draining quickly. Due to its non-water-retaining characteristics, it continues to hold together fairly well but when compacted and wet, in the same way which good soils do it for base stability. When the atoms become wet, their friction decreases and they may be swept away, leaving a hole underneath the this same foundation [16]. Topsoil is indeed the ideal sandy soil because it's made up of sand, silt, and clay. It is velvety to a contact and black in color, which keeps dampness and crumbling at bay. Loam is an excellent foundation support material due to its evenly split qualities, notably how it keeps liquid at a balanced speed. Loam is a good soil for aiding a foundation because quasi soils seek their own way to the surface[17]. Bedrock, granite, sandstone, schist, and difficult chalk are examples of rocks with high bearing capacity. These are exceptionally strong and suitable for behavior and provides the groundwork due to their stability and depth. The foundation will be adequately supported in the future as long as the rock is staged [18].

2.2 FAILURE IN SOILS

Is an improper difference in manner between predictable and experimental performance, according to the American Society of Civil Engineers. Although failure may be viewed by the general public as a catastrophic structure collapse [19]. The numerous foundation failure causes are as follows [20]:

a. Lateral motions

b. Failures due to load shifting

c. Vibrational impacts

d. Floating and the amount by which water level varies

e. Design and construction flaws Earthquakes

f. Uplift pressures

g. Landslide/slope instability

2.3 TYPES OF FOUNDATION SOIL SHEAR FAILURE

The following are the methods of experienced of the shear failure with the help of the foundation soil, depending on the stiffness of the base soil and the depth of the foundation.

Shear failure in general [21]:

a. Failure due to local shear

b. Failure of a punching shear

c. Base soil shear failure

d. Foundation soil failure

2.3.1 Shear Failure

This kind of failure is common in dense, rigid soil. The trying to follow are features of community shear failure[22]:

a. The edge of the footing and the ground surface, a continuous, well-defined, and identifiable failure surface emerges.

b. This failure happens in dense or rigid soil with low compressibility.

c. There is continuous shear mass bulging near the footing.

d. Failure is preceded by a footing tilting.

e. Failure is abrupt and catastrophic, with a clear peak inside the curve.

f. The length of disturbance beyond the footing's border is considerable.

h. The state of foam balance is first achieved at the pile foundation edge and then negative reinforcement and protrudes.

2.3.2 Local Shear Failure

This is common type of failure in loose as well as soft soil. The following are features of general populace shear failure[23]:

a. A significant density of specific soil less the footing is noted, as well as a limited upgrade of plastic balance.

b. The Failure is not abrupt, then there is no footing tilting.

c. The failure surface doesn't really reach the earth surface, as well as the specific soil encompassing the footing has little bulging.

d. The maximum stress is unclear.

e. Failure is characterized by significant settlement.

f. The curve appears to lack a distinct peak.

2.3.3 Soils with Punching Shear Failure

a. This type of failure is common in loose, soft soil especially at higher elevations. Routing is one of the features of general shear failure.

b. This type of failure occurs in soil with such a high deformation.

c. There isn't any pattern of failings.

d. There isn't any specific dirt clumping around the foundation.

e. Failure is differentiated by such widespread large colonization [24].

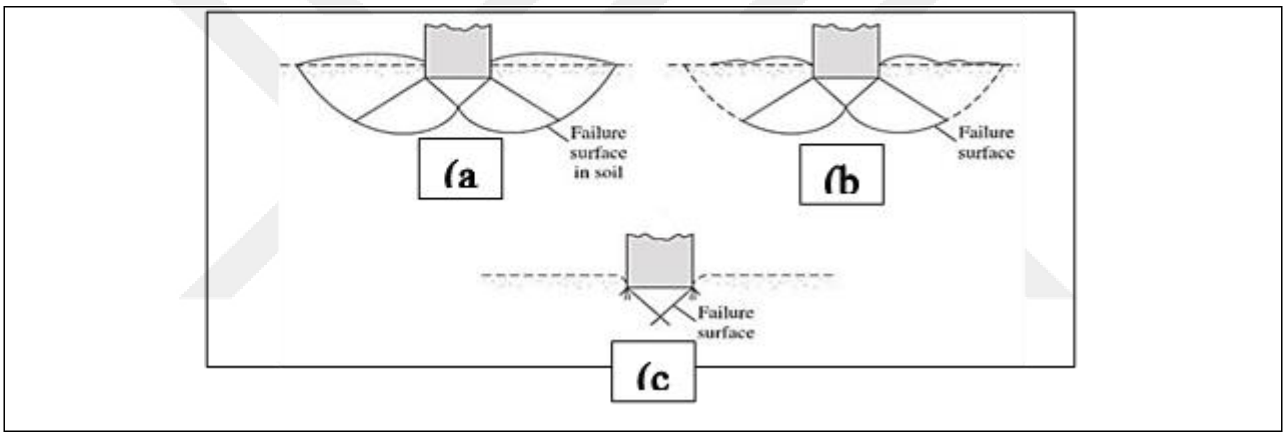

Figure 2.1: Soil Failure: (a) General Of Shear (b)The Local Shear (c) The Punching Shear [21]

Failure of the bearing capacity usually happens is consider one of three manners: general shear force failure, local shear force failure, or punched shear failure, the failure mode of a non-deep of the foundation is determined by factors such as soil relative compressibility, footing embedment, forces action circumstances, and discharge water conditions. The rupture pattern of common shear failure is exact, involving of three zones. Local shear failure is typically characterized by obviously defined separation surfaces beneath the balance. The failed pattern just on footing's edges, on the other hand, is poorly defined. Punch due to sheer failure does have a bad defined burst form that is determined in sector I; it is often linked to a great settlement then fails to organize[25].

Failure indicates that [26]:

a. General limit equilibrium equation for a packed footing having failed in the overall shear mode can be developed.

b. Because of their poorly defined rupture surfaces, it is difficult to generalize the in not as shallow foundations in two failure modes.

c. It is critical to understand the amplitude of settlements needed to mobilize middle to upper.

2.4 FOOTING STRIP

A load-bearing wall is given a strip footing. A strip footing is the same one supplied for a row of columns that are so closely spaced that their spread footings overlap or nearly touch each other. In this scenario, a strip footing is more cost effective than a rank of spread footings in a single line. A continuous footing is also known as a strip footing [27].

2.4.1 Individual Footing

A spread footing, also known as an isolated footing, pad footing, or individual footing, is used to support an individual column. A spread footing is a uniformly thick circular, square, or rectangular slab. It is sometimes stepped or hunched to spread the load across a larger region [28].

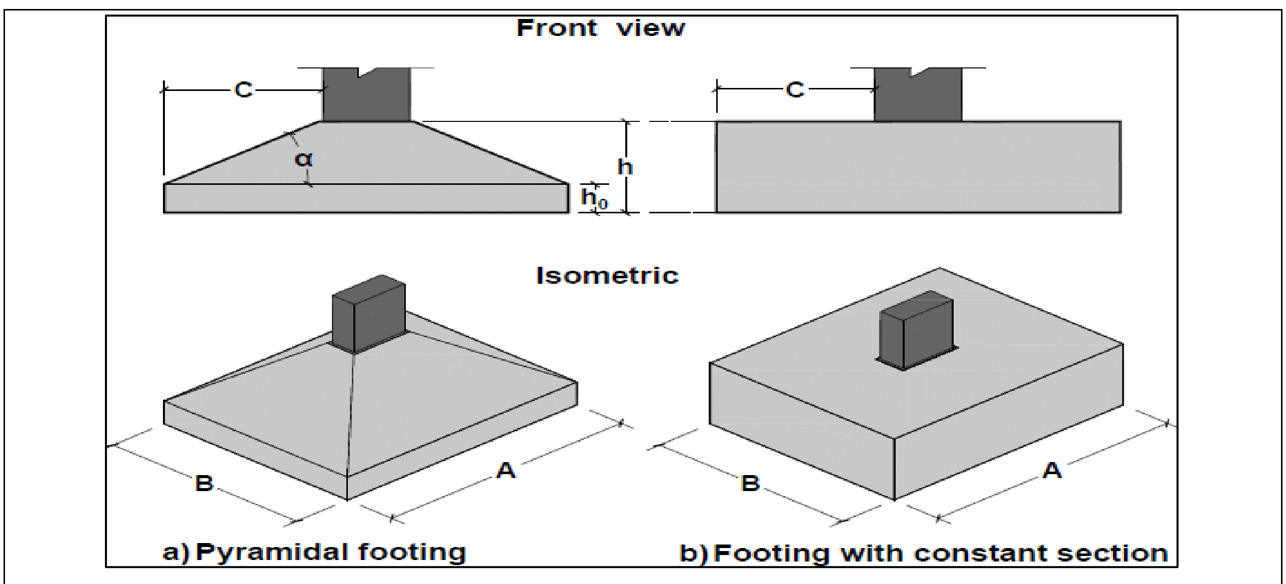

Figure 2.2: Isolated Footings [29]

2.4.2 Combination Footing

This range is used when there are a large number of columns and they are very close to each other so that their bases are very close together. In such a case an aggregate rule is used especially in the case of the boundary line being so close to one column that in this case the distribution rule is loaded unconventionally. Through the process of combining it with an inner shaft, the load is evenly distributed[30].

2.4.3 Strap or Cantilever Footing

Strap stability is composed of two distinct concrete foundations joined together by a structural strap or even a lever. The strap links the two footings, enabling them to work together as a unit. The strap is constructed from a strong beam. The individual pile foundations are configured so that their combined action line passes thru the maximum load resultant. A strap substructure is much more cost effective than just a combination footing when the allowed soil force is pretty high and the spacing between the sections is large[31].

2.4.4 Raft Foundations

A mat or raft foundation is a huge slab that supports a number of columns and walls beneath the entire structure or a significant portion of the project. A mat is required when the allowed soil pressure is minimal or when the columns and walls are so close that individual footings would overlap or almost touch each other. Mat foundations are beneficial in reducing differential settlements atop non-homogeneous soils or if there is a large fluctuation in the stresses on individual columns [32].

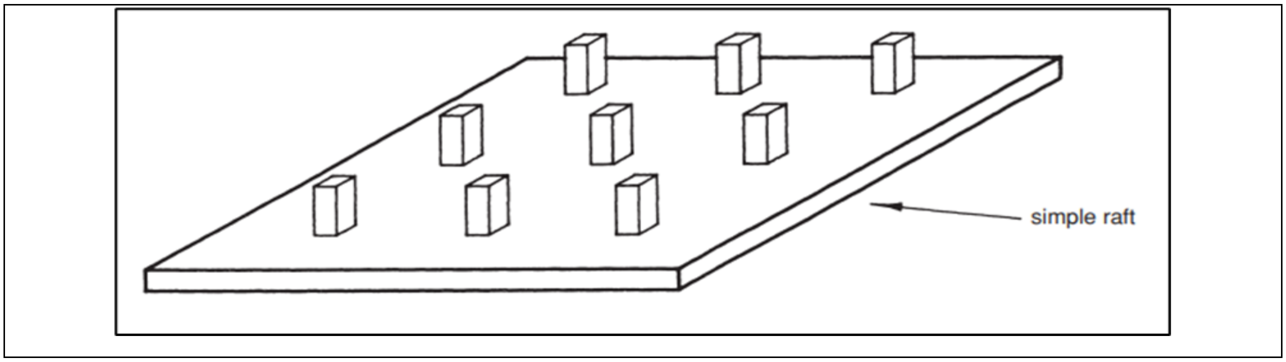

Figure 2.3: Raft Foundation[33]

2.5 BEARING CAPACITY

Bearing ability, in a nutshell, is the ability of soil to support pressures applied to the land above. It is mostly determined by the type of soil, its shear strength, and density. It is also dependent on the depth of embedment in which the load is formed the deeper it is founded, the larger the carrying capacity. Where there is insufficient bearing capacity, the ground can be improved or the load can be spread over a broader area so that the total stress to the soil is reduced to a value smaller than the bearing capacity. This can be accomplished with spread foundations made of reinforced concrete [34]. In the case of crane and piling rig platforms, improved load spread is provided by a granular platform, the performance of which can be further enhanced by mechanical stabilization utilizing. When a load is placed on the ground, such as from a construction foundation, a crane, or a retaining wall, the ground must have the capacity to help it without undue settlement or failure [35].

This means that the bearing capacity of the underlying soil must be calculated as part of the design process for any building project. Failure to comprehend and account for ground bearing pressure before beginning a construction project can have disastrous effects, such as a building base collapsing later on [36]. As a telling result of the elastic-plastic equilibrium problem, the computation of final bearing capacity for non-deep foundational principles on specific soil can be significant. Even so, the difficulty in selecting a computational formula of soil constitutive relationships prevents us from finding closed analytical solutions. The traditional theory of plasticity limits the bearing capacity approach to rigid-plastic solid solutions. As a consequence, for the stated problem, only approximate techniques are now available[37].

2.6 REQUIREMENTS OF DESIGN

Any foundation should, in general, take into account three essential requirements: Sufficient required safety against foundation structural failure; for soil beneath the suitable bearing capacity of the founding with against specified of the safety abject defeat Under doing lots and lots, appropriate total or differential agreements Moreover, the general consistency of slopes near a dominant footing must be taken into account as amount of the design of foundation. For just one project, it is necessary to look into all of the bearing capacity and footing settling. As to if footing deflection is governed by bearing ability or settling limit is determined by a variety of factors including soil condition, bridge type, footing aspects, and loads[38]. In practice, any foundation should be built to and designed offer a particular level of protection in contradiction of failure bearing capacity or settlement of excessive. A safety parameter is a proportion of the final load to the allowed loading [39].

2.7 CURRENT WORK

The study aimed to investigate the behavior of soil bearing capacity and its ability to carry out shallow foundation. The study analyzed the strength of various soil types and built its outline based on the effective parameters that influence the stability of the foundation including the applied weight and geometrical shape. The study showed the input and the output data in related tables and figure to support the designers in their decision to that target soil. The Analysis was implemented with statistical analysis using SPSS program and simulation was made for the foundation cases using ANSYS Workbench program.

2.8 LITERATURE SURVEY

The study shows that the recent increased interest in assessment methodology and performance-based seismic design, it is believed that more accurate modeling of the structural system is critical in the study, planning and evaluation of all newly constructed and existing buildings during earthquakes. The element is simple but effective in showing the essential elements of a shallow soil foundation system (slip, stability, and sway). Two experimental results from centrifugal-scale and large-scale cyclic forces interaction tests on quasi-bases are used to demonstrate model properties and verify modeling accuracy. The idea of stability on Winkler-based soils is easily supported by the Euler-Bernoulli hypothesis about sectional kinetics. The contact section response is represented using the fiber section estimation. The deterministic function is a appropriate way to direct the stress-deformation behavior of any soil fiber. y. Based on this comprehensive validation of the model, it was discovered that the modeling works fairly well. It is very similar to the experimental data in terms of moment requirements, shear strength, flattening and rotation. The model also captures well the hysterical behavior of momentary spin responses and the spin flattening feature As a result, the shallow core is a vital component in the implementation of this seismic derivation and assessment approach. This work presents the contact interface fiber section element for use in typical shallow soil foundation systems[40].

(M. Yenes, et al., 2012) The study showed that it is often possible to build pile on large soils. When shallow piling is used in these materials,. The coil covers the bearing capacity of unsaturated expanded soils for a given suction value and indicates that the bearing capacity is enhanced by 26 percent when the suction effect is considered. However, an increase in water content may lead to a decrease in suction and therefore a decrease in bearing capacity. The carrying capacity of unsaturated expanded soils for a given suction value was estimated using the high coherent plasticity levels detected for the El Viso geotechnical unit as an example. The bulge pressure can be determined and the piling can be built to provide more pressure to compensate. Obviously, it will also be important to determine the capacity of the Earth to withstand this load. As a result, when designing shallow foundations on extensive soils, it is necessary to take into account capable changes in the water content of the soil, which can lead to a significant decrease in the bearing capacity of the soil and swelling or collapse, depending on the size of the load transferred to the soil .The results showed that when the soil hardness increase due to suction is considered, the specific soil bearing capacity is enhanced at the maximum average value at which swelling pressure is taken by 26 percent. This is similar to the results of Alonso et al. . (1987), who discovered that an increase in suction leads to an increase in hardness in unsaturated expanded soils, while a decrease in suction leads to a softening of the soil[41].

(M. Mohammed, et al., 2020) The study showed that simulation of stability in cohesion materials is an important topic for understanding the complexity of soil cohesion texture. The research focuses on implementing newly developed machine learning models called Hybrid Neural Fuzzy. Moreover, the results revealed that pre-processing of information is critical before creating predictive models As a result, two distinct model scenarios were examined first, the pre-processed (data set and the unprocessed data set. Inference System with Particle Swarm Optimization , Ant Colony Optimizer , Differential Evolution, and Genetic Algorithm as effective methods for predicting stability In any of the shallow foundations above the properties of cohesive soil. Predictive factors include base width , base stress , base geometry , number of SPT strokes , and foot inclusion ratio (Df/b). The heterogeneity or inconsistency of the data set used is a fundamental challenge in predictive modeling. Multiple statistical indicators were produced and examined during the training and testing periods to assess the accuracy of the hybrid models used and the independent models. The results showed that the modeling provided valuable and reliable prediction data intelligence and had the highest prediction performance among all the models used. [42].

(E.Al-Taie, et al., 2015) The study confirmed for the purpose of determining the size of settlement within different types of weak soils, 79 samples were collected from 23 sites scattered in three regions in Iraq: Mosul, Baghdad and Basra in the northern, central and southern parts of the country.. The mean and minimum values for tolerance were used. For design and analysis, the program used proportional sub-score response unit values. , the constant type is the most adequate, safe, and expense form for use in the areas of Erbil, Baghdad, again for overall average of the capacity, while the form of raft is precise to a Basra region .The related software was employed to create and solve this same foundations as well as calculate this same settlements for the three aspects under various types of construction (raft and constant)[43].

(M. Chwała & W. Puła, 2020) In this work, the study concerned with such a probabilistic method for determining the load carrying capacity of surface surfaces. Actually imply along the dispersion zones. The mechanism employs aircraft stressors; however, due to three-dimensional soil spatial heterogeneity, the impact of base length over an arbitrary load carrying capacity appraisal is considered in this study. As just a result of the estimate, a set of cross - correlation random variables is acquired. A installment of numerical computation are performed on two different thickness of the first layer, as well as the anisotropy rule again for spatial heterogeneity of the untrained strength properties. The evaluation employs a kinetic technique. This same substrate under consideration is composed of two types of land: a top part of medium as well as dense sand and a layer of fine terra cotta. The sandy overlay is thought to just be homogeneous, whereas the soft clay layer's unlined shear strength is thought to just be regional level variable, even though described by such a log-normal arbitrary field. The itemized approach is computationally effective and takes into account 3D regional heterogeneity in soil ultimate strength. The outcomes are examined and compared to those obtained using other methods [44].

(M. Abu-Farsakh, et al., 2008) The study's goal was to investigate the possible advantages of using specific rammed earth underpinnings to enhance load carrying capacity as well as prevent weak soil peace agreement on the soil. Furthermore, an instrument program consisting of stress cells and stress gauges was created to explore the stress distribution in the soil mass with and without reinforcement, as well as the stress distribution on the reinforcement. Test results have shown that adding reinforcement container significantly increase the bearing capacity and decrease footing stability. Higher tensile modulus geogrids performed better than lower tensile modulus geosynthetics. Because the rinsing founded along the reassurance is clearly relevant to the settling, more than one modulus can develop higher tension in geomorphological networks under the same foundation settlement. The experimental findings also showed that the inclusion of additional troops will redistribute this same applied loads over a larger area, lowering tensile stress and creating a more homogeneous load transfer. Prospective stress redistribution below the bolstered zone will result in lower foundation settlement of a underlying weak heavy clay, which is directly related to the resulting stress. To achieve this goal, the Louisiana Mass transit Research Center conducted 117 tests, including 38 research lab typical tests over boggy bridge soils, 51 laboratory typical exams over soil, and 22 laboratory typical tests over quarry dust in Kentucky, as well as 6 big field tests on clay mud bridge soils. The effects of various variables and elements that influence the enhancement of the intervention of a specific reinforced foundation system are invited in these tests. A non-significant stress in the grovel measured outside its effective length of 4.06.0B revealed that the geonetwork provides a subtle additional strengthening effect further than this length. Besides that, finite element analyses were carried out to assess the advantages of strengthening bridge soils with moderate to low plasticity but also crushed granite with geogrid under a strip bed in regards to maximum load carrying capacity and base stability. Based on numerical analysis, several geographic upgrade design criteria have indeed been investigated[45].

(R. Saravanan, et al., 2020) This experimental study task was carried out to evaluate the settlement and the bearing capability in consistent soil. The primary area of this study is to increase the present state of information relating to the current modeling processes in order to evaluate its settlement and load carrying capability. To analyze the scale effect, three types of modeling footing were used in the experiments: square, rectangular, and circular shapes. Semi-empirical approaches were researched from the prior literature study to determine the settlement and bearing capacity parameters. Based on earlier research, the investigation was divided into three components. In the beginning, the index and laboratory experimental investigations were carried out. A steel tank with a volume of 330220300 mm was built and tested for modeling purposes[46]. (A. Elhakim, 2005) The study showed that the stress behavior in the foundation soil, which is complex and affected by stress level, loading direction, anisotropy, stress rate, age and drainage, significantly affects foundation performance. The shear modulus of small strain is closely related to ground materials..The primary objectives of this research are: (1) to investigate the gradient parallelism between the stress-strain performance of a single-state soil component and the load-displacement capacity of the non-deep foundation system evaluated on the soil; and (ii) develop a procedure for evaluating the performance of vertically loaded bases using a rational framework as the basis for the small stress modulus, Gmax. Gmax is a basic stiffness applicable to all monotonous static or dynamic loading conditions, including vacuum and non-dried loading. On the other hand, Gmax is too harsh for inline use in computational foundation displacements using simple elastic analysis tools or linear viscoelastic foundational models built into geotechnical finite element software [47]. (M. Nouri, 2014) The study showed that in the foundation engineering site, the bearing capacity of any foundation is the main concern. Structures may be built on or near slopes either for ground constraint reasons, such as retaining walls and bridge abutments, or for architectural reasons.. For diverse granular soils, the software simulates 328 models in total. Initially, certain calibrations were made in order to obtain the best condition for the modeling simulation. Both the soil field size and the number of meshes were calibrated to the soil volume and loading velocity. As a result, many simulation parameters related to the geometry condition and soil properties were changed, such as the angle of inclination of the load with different vertical slope angles, different distance from foundation to slope edge, different friction angles, and different expansion angles. Then, the results obtained with the help of the program are compared and validated with the theoretical solutions that can be reached in order to check the quality of the results obtained in this way. An analytical solution that takes the effects of gradient into account is provided to the problem of predicting the interaction field of a bar foot resting near a slope. The presence of the slope has a great influence on the bearing capacity of the foundation of those buildings. Under these conditions, the design of the foundation is complex, and the data available in the literature are limited. Using the explicit finite variable program "FLAC" and the fully elastic plastic soil constituent law, a numerical model was built to simulate the condition of the strip foundation near the slope. The individual parameters influencing this behavior were examined in order to evaluate their effects above the final bearing capacity and the site of interaction at which the vertical and horizontal case loads of the bar base interact. Furthermore, a design scheme is developed to project the final bearing capacity of the a shallow foundation while accounting for the angle of expansion, which was not included in previous works. For practical purposes, design theory, derivation technique and diagrams are provided [48]. (P. Kolay, et al., 2020) The study analyzed the enhancement of the bearing capacity of clay loam soils with a thin sandy layer over the top and the placement of geogrids at different depths. Load versus stability curves for an unreinforced and reinforced soil system were generated using a model test of a rectangular footer resting on the above plane of the selected soil. The bearing capacity of a particular soil increases at a rate of 16.67 percent when one geogrid layer is combined at the soil interface equal to 0.667, and grows at a rate of 33.33 percent when combined with one geogrid layer equal to 0.33. The bearing capacity of the bottom sandy silt clay was increased by 44.44 percent, 61.11 percent and 72.22 percent for the two, three and four geogrid layers, respectively. The results of this research work may be of value in improving the soil bearing capacities of shallow foundations and pavement design for similar types of soils available elsewhere the test results focus on the improvement in the bearing capacity of clay and sand clay on a non-reinforced, reinforced soil system in a semi-form, referred to as BCR. The results show that the bearing capacity increases significantly with the increase in the rank of the geographical network layers. [36].

3. METHODOLOGY

3.1 INTRODUCTION

A strip base of width B is located of the outer dense surface of the amount of the sand or on the cohesive and solid soil, as shows in figure 3.1a. All loads are slowly pragmatic to the foundation, as the increase of the settlement. The change in the load of the foundation per unit of the area (q) which occurs as a result of leveling the foundation soil. The load per unit area when it is equal, where a sudden and rapid failure occurs within the soil components that support this foundation and the maximum stress extends in the soil to the ground level. Where this load per unit area is called the maximum or final bearing capacity of the foundation. Shear failure generally occurs when there is rapid failure within the soil components. The foundation that is being constructed and is under study and consists of medium pressure sand or clay soil, the increase in the level of load on the foundation will lead to the soil being more stable. However, in this case, as indicated by the solid lines, the surface of the failure itself within the soil will be gradually extending outward from the foundation. Sudden base tremors occur when the load per unit area is equal to the base level. It is very important after that the foundation is moved so that the stress concentration inside the soil extends to the depths of the earth's surface. The load is usually defined per unit area where this occurs as the final bearing capacity, qu, increasing the load will result in significant ground movement. The load per unit area is basically the first failed load. Obviously, this type of failure, called ground shear failure, does not realize the magnitude of q. In case the foundation is supported by soil which is rather loose, the scheme for leveling the load is as per Fig. 3.1c. In this case, the maximum pressure applied to the soil will not extend to the surface of the earth. After the final pregnancy. Perforation spill is a term used to describe this type of ground failure.

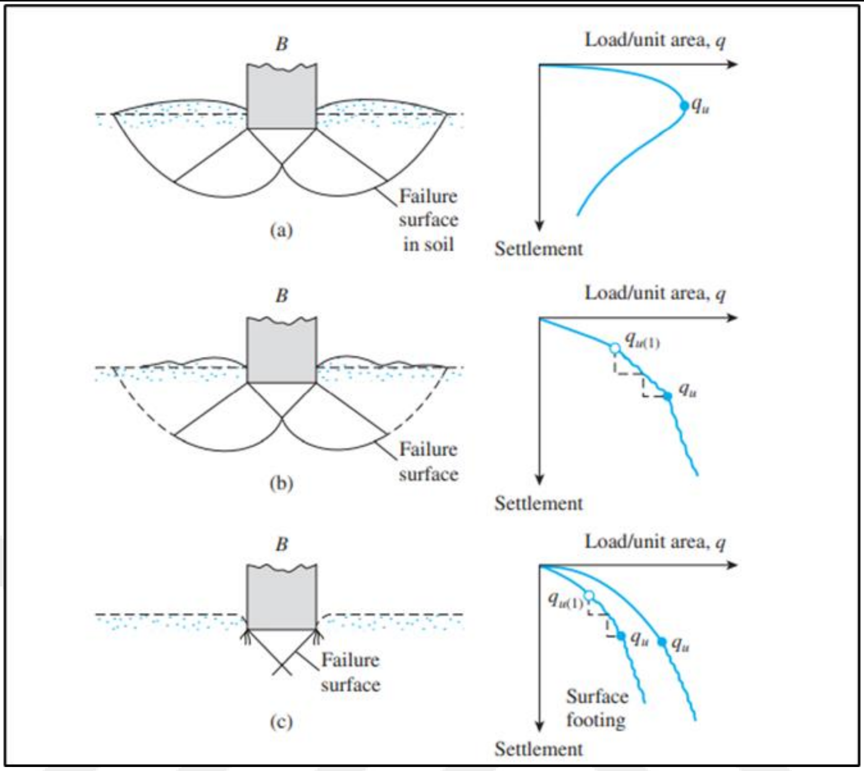

Figure 3.1: Nature Of Bearing Capacity Failure In Soil: (a) General Shear Failure: (b) Local Shear Failure; (c) Punching Shear Failure [49]

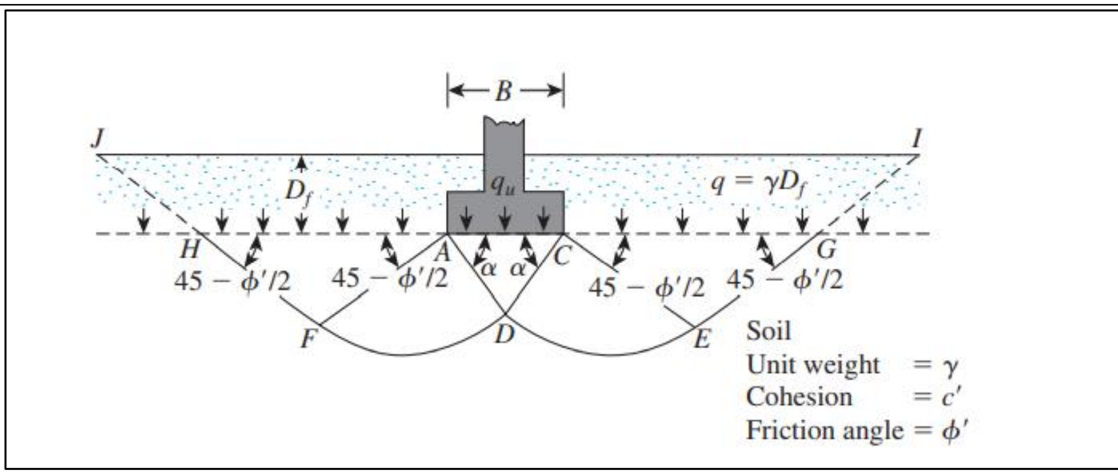

Figure 3.2: Failure Of Bearing Capacity In Soil Beneath A Rough Rigid Constant (Strip) Foundation [50]

$$q = \gamma \ D_f \tag{3.1}$$

$c' = cohesion\ of\ soil$

$\gamma = unit\ weight\ of\ soil$

The ultimate bearing capacity of soil is:

$$qu = c'Nc + q\ Nq + \frac{1}{2}\ \gamma\ B\ Ny \tag{3.2}$$

$$Nq = \frac{e^{2\left(\frac{3\pi}{4} - \frac{\emptyset}{2}\right)\tan\emptyset}}{2\ cos^2(45 + \frac{\emptyset}{2})} \tag{3.3}$$

$$Nc = \cot\emptyset\ \ (Nq - 1) \tag{3.4}$$

$$Ny = \frac{1}{2}\ \left(\frac{Kpr}{cos^{\ 2}\ \emptyset} - 1\right)\tan\emptyset \tag{3.5}$$

For rectangular foundation, the general equation is:

$$qu = c'Nc\ \ Fcs\ \ Fcd\ \ + q\ Nq\ \ Fqs\ \ Fqd\ + \frac{1}{2}\ \gamma\ B\ Ny\ \ Fys\ \ Fyd \tag{3.6}$$

For the modification of failure angle from Ø to 45+Ø/2: the equation factors Nc, Nq, and Ny are were calculated from the following equation:

$$Nq = \ tan^2\ \left(45 + \frac{\emptyset}{2}\right)\ e^{\pi\tan\emptyset} \tag{3.7}$$

$$Nc = (Nq - 1)\ \cot\emptyset \tag{3.8}$$

$$Ny = 2(Nq + 1)\tan\emptyset \tag{3.9}$$

$$Fcs = 1 + \left(\frac{B}{L}\right) \left(\frac{Nq}{Nc}\right) \quad (3.10)$$

$$Fqs = 1 + \left(\frac{B}{L}\right) \tan Ø \quad (3.11)$$

$$Fys = 1 - 0.4 \left(\frac{B}{L}\right) \quad (3.12)$$

For $\frac{Df}{B} \leq 1$

For Ø =0

$$Fcd = 1 + 0.4 \left(\frac{Df}{B}\right) \quad (3.13)$$

$Fqd = 1$

$Fyd = 1$

For Ø >0

$$Fcd = Fqd + \frac{1 - Fqd}{Nc \tan Ø} \quad (3.14)$$

$$Fqd = 1 + 2 \tan Ø \, (1 - \sin Ø)^2 \left(\frac{Df}{B}\right) \quad (3.15)$$

$Fyd = 1$

For $\frac{Df}{B} > 1$

For Ø =0

$$Fcd = 1 + 0.4 \, tan^{-1} \left(\frac{Df}{B}\right) \quad (3.16)$$

$Fqd = 1$

$Fyd = 1$

For Ø >0

$$Fcd = Fqd + \frac{1-Fqd}{Nc \tan Ø} \tag{3.17}$$

$$Fqd = 1 + 2\tan Ø\,(1-\sin Ø)^2\, tan^{-1}\left(\frac{Df}{B}\right) \tag{3.18}$$

$$Fyd = 1$$

The safety factor:

The final stress per unit area of something like the foundation that is backed by the soil in overabundance of the pressure created by the underlying ground at the foundation level is defined as the net bearing capacity. If indeed the difference in unit weight between the concrete used in the founding and the soil encompassing it is believed to be negligible, then:

$$q(allowable) = \frac{qu-q}{Fs} \tag{3.19}$$

Modification the equation by water table:

The effect of the water table under the foundation can be assigned for three cases:

Case1: when the water table above the foundation-soil level so that

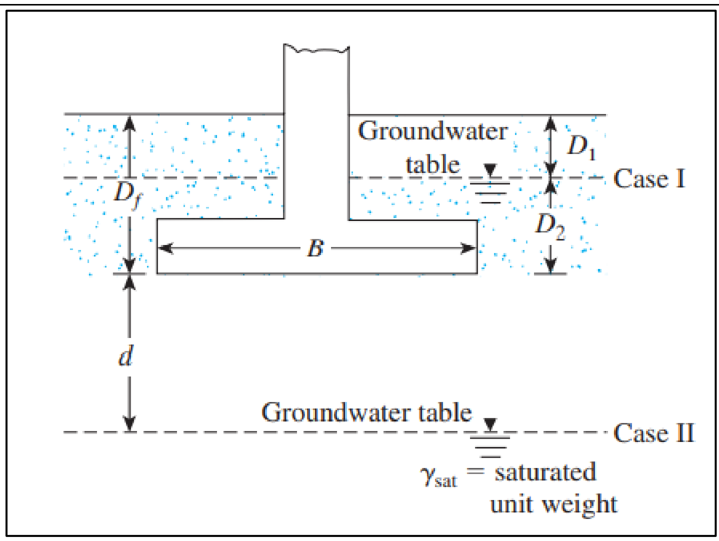

Figure 3.3: Bearing Capacity Case With Water Table [49]

In this case the value of q identified as following:

$$q = D1\gamma + D2\,\gamma' \quad (3.20)$$

$$\gamma' = \gamma sat - \gamma w \quad (3.21)$$

Case2:

When the water table level is lower than the level of the foundation-soil attachment but the distance between the two levels is less than or equal to the width of the foundation B, the following conditions apply:

In this case, the factor must be replaced by the factor in the last term of the bearing capacity equation.

$$\bar{\gamma} = \gamma' + \frac{d}{B}\,(\gamma - \gamma') \quad (3.22)$$

$$\gamma' = \gamma sat - \gamma w \quad (3.23)$$

Case3:

When the water table level is lower than the level of the foundation-soil attachment but the distance between the two levels is greater than the width of the foundation B, the water impact can be ignored.

Table 3.1: The Strength Properties Of Various Soil Types[51]

Soil type	Symbol	Min Ø	Max Ø	C (kN/m^2)
Gravel well granulated	GW	40	50	0
Gravel is well granulated with clay binder	GC	45	50	0
Gravel of the uniform composition	GU	35	40	0
Gravel poorly granulated	GP	30	40	0
Gravel with a lot of fine particles	GF	30	35	0
Sand well granulated	SW	30	35	0
Sand is well granulated with clay binder	SC	35	40	4.9
Sand of uniform composition	SU	30	35	0
Sand poorly granulated	SP	25	30	0
Sand with a lot of fine particles	SF	15	25	4.9
Dust (silt) of low plasticity	ML	10	22	9.81
Clay of low plasticity	CL	8	20	14.71
Organic of the clay of low plasticity	OL	5	15	19.61
Dust (silt) of the medium plasticity	MI	5	15	19.61
Clay of the high plasticity	CH	0	8	29.42
Organic clay of the high plasticity	OH	0	5	39.23

Table 3.2: The Dry And Saturated Unit Weight Of Soil For Various Types[52] [53]

Symbol	Unit weight dry (pcf)	Unit weight saturated (pcf)
GW	120	130
GC	115	130
GU	115	125
GP	120	130
GF	120	130
SW	115	133
SC	110	122
SU	110	122
SP	110	122
SF	107	120
ML	92	105
CL	95	102
OL	95	100
MI	92	97
CH	95	100
OH	95	97

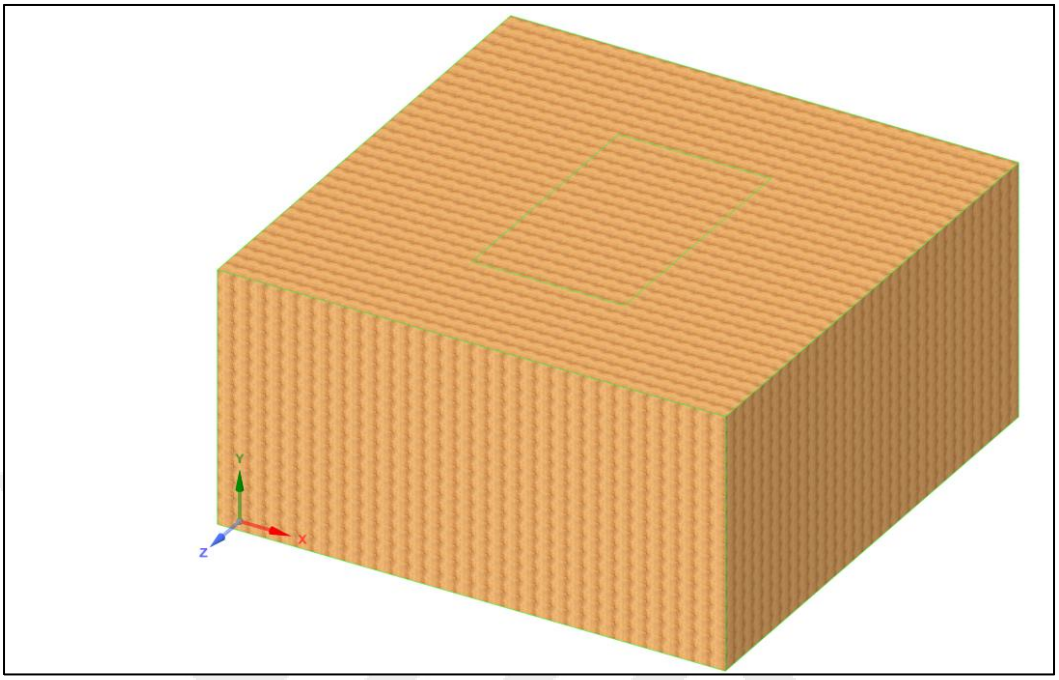

Figure 3.4: ANSYS Geometrical Drawing For Soil Body

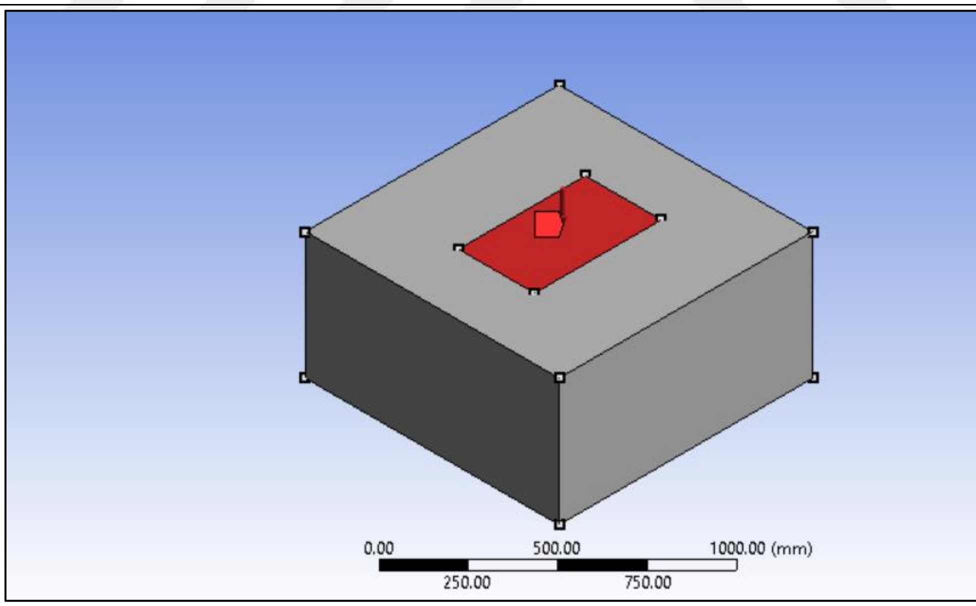

Figure 3.5: Applying The Stress By Foundation On The Soil Body in ANSYS

4. RESULT

4.1 CALCULATION AND RESULTS

The identifying of the ultimate bearing capacity of soil is based on the determination of the values of the factors inside the main equation; the friction angle of the soil is independent factor that appeared in the equation of Nc, Nq, and Ny. The variation of the angle values lead the data of the factors that explained in table 4.1.

Table 4.1: The Effect Of The Internal Friction Angle On The Bearing Factors

Ø	Nq	Nc	Ny
1	1.094	5.379	0.073
5	1.568	6.489	0.449
9	2.255	7.922	1.031
13	3.264	9.807	1.969
17	4.772	12.34	3.529
21	7.071	15.81	6.196
25	10.66	20.72	10.88
29	16.44	27.86	19.34
33	26.09	38.64	35.19
37	42.92	55.63	66.19
41	73.9	83.86	130.2
45	134.9	133.9	271.7
49	265.5	229.9	613.1

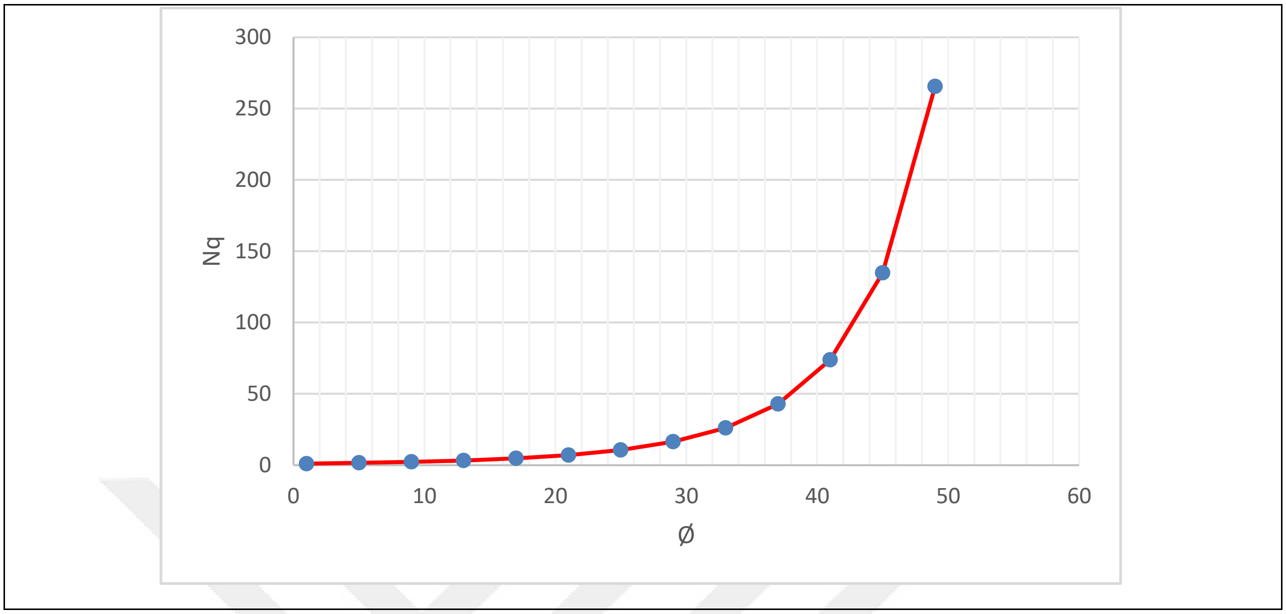

Figure 4.1: The Relationship of Ø and Nq

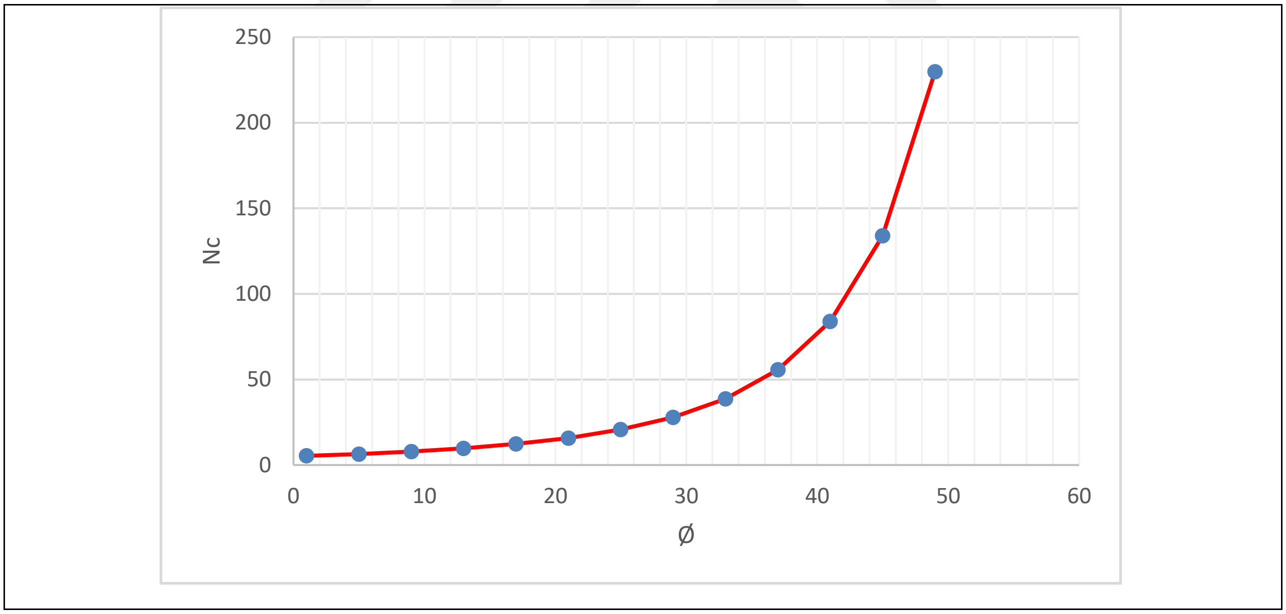

Figure 4.2: The Relationship of Ø and Nc

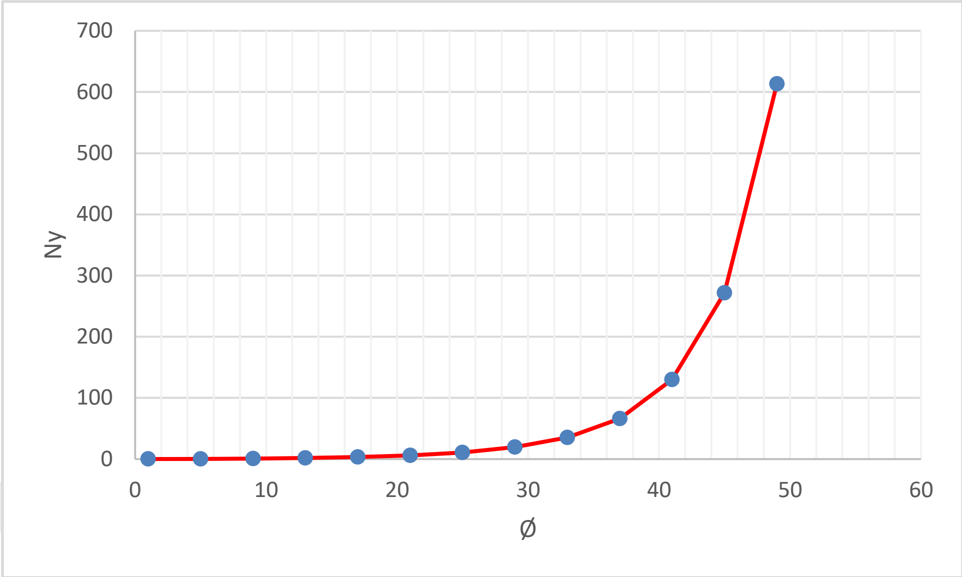

Figure 4.3: The Relationship of Ø and Ny

By applying the curve fitting technique:

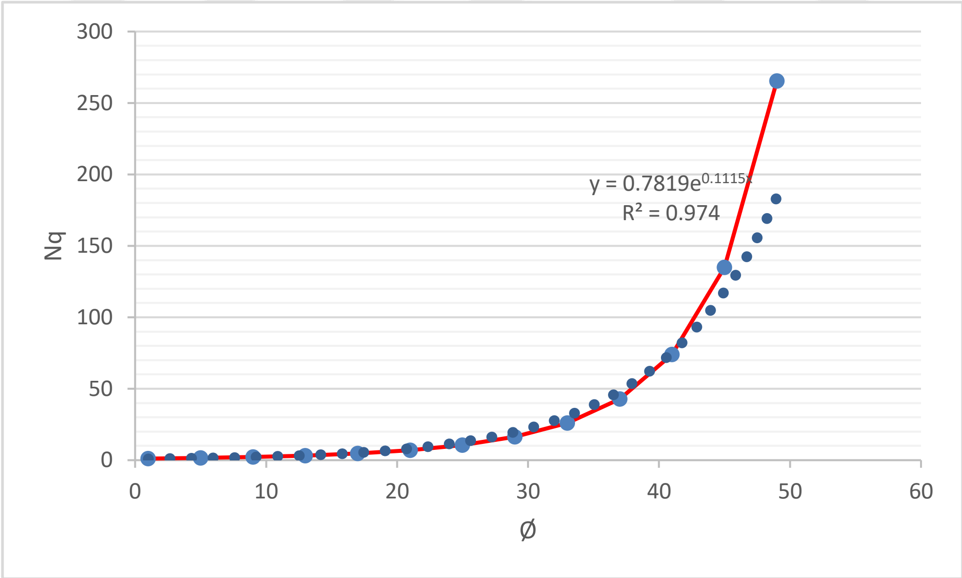

Figure 4.4: Curve Fitting For The Relationship of Ø and Nq

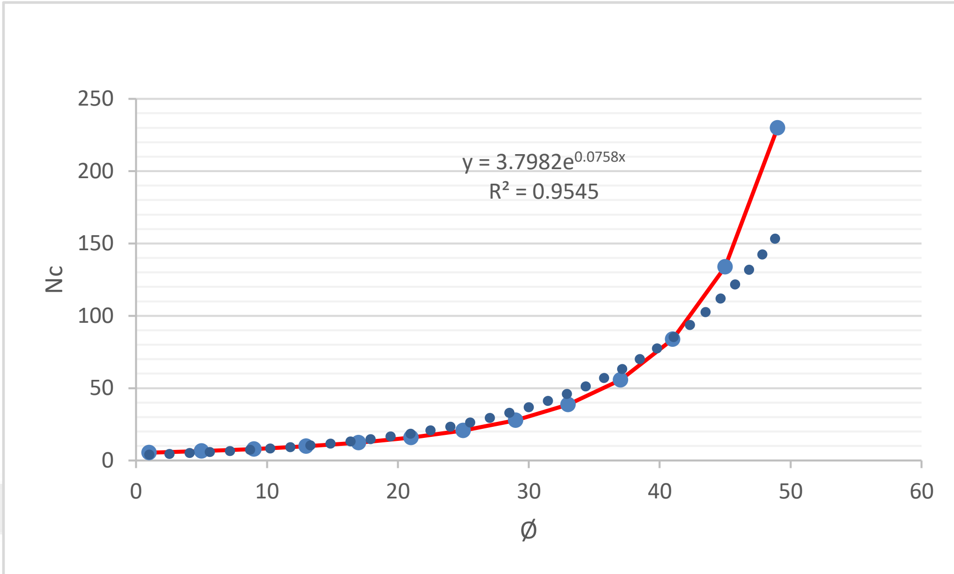

Figure 4.5: Curve Fitting For The Relationship of Ø and Nc

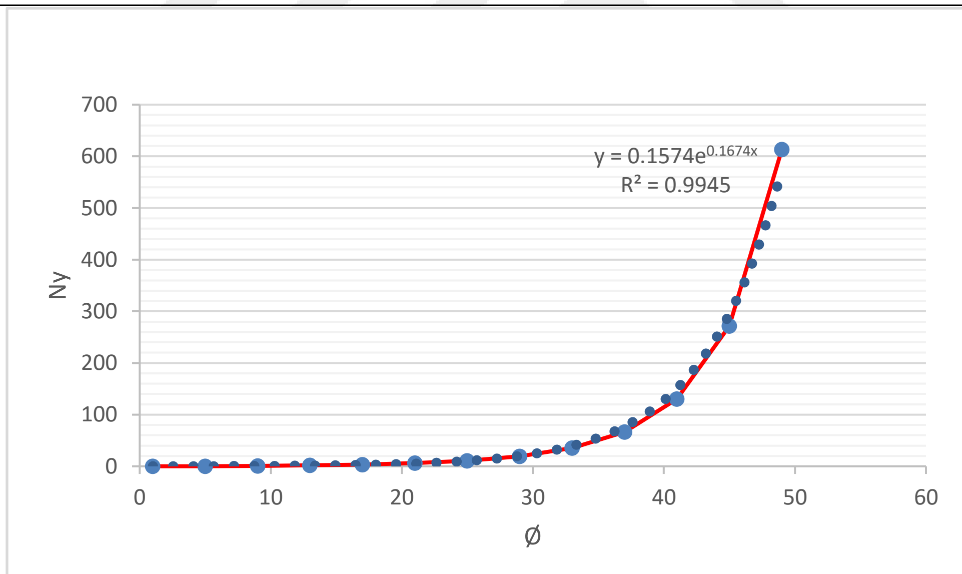

Figure 4.6: Curve Fitting For The Relationship of Ø and Ny

From the three curves fitting applications:

$$Nq \; == \; 0.7819 \, e^{0.1115\, Ø} \tag{4.1}$$

$$Nc \; = \; 3.7982 \, e^{0.0758\, Ø} \tag{4.2}$$

$$Ny = \; 0.1574 \, e^{0.1674\, Ø} \tag{4.3}$$

Table 4.2: The Effect Of The Internal Friction Angle On The Shape And Depth Factors

Ø	Fcs	Fqs	Fcd	Fqd
1	1.203	1.017	1.393	1.034
5	1.242	1.087	1.403	1.146
9	1.285	1.158	1.405	1.225
13	1.333	1.231	1.4	1.277
17	1.387	1.306	1.387	1.306
21	1.447	1.384	1.368	1.316
25	1.515	1.466	1.343	1.311
29	1.59	1.554	1.313	1.294
33	1.675	1.649	1.28	1.269
37	1.772	1.754	1.245	1.239
41	1.881	1.869	1.208	1.206
45	2.007	2	1.173	1.172
49	2.155	2.15	1.139	1.138

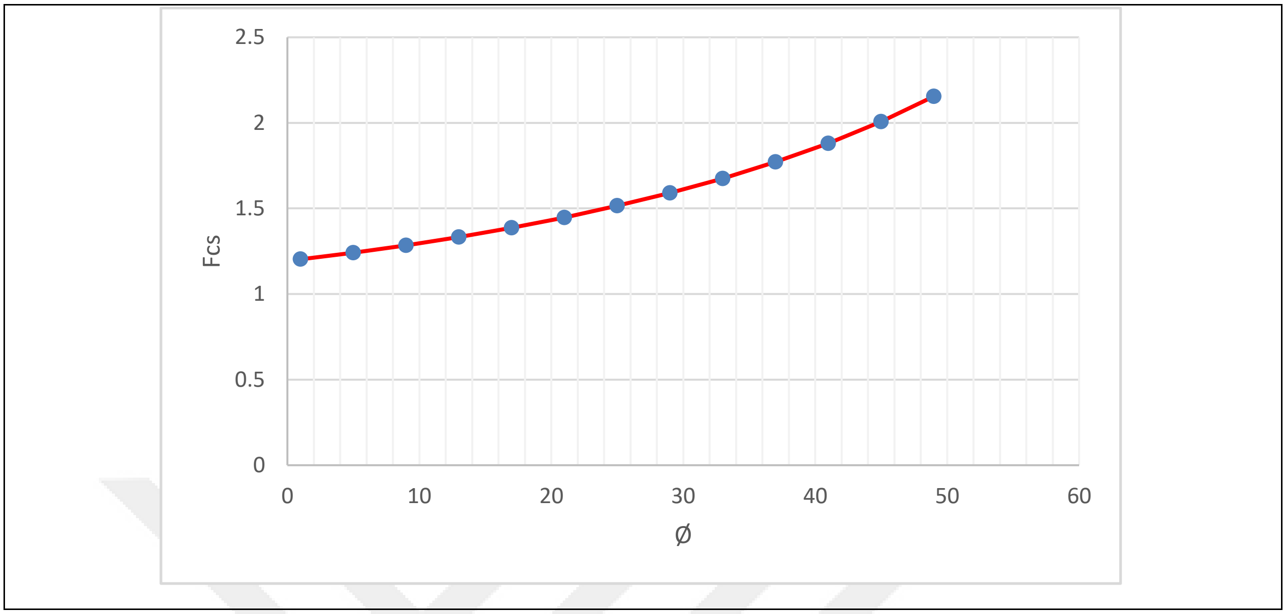

Figure 4.7: The Relationship of Ø and Fcs

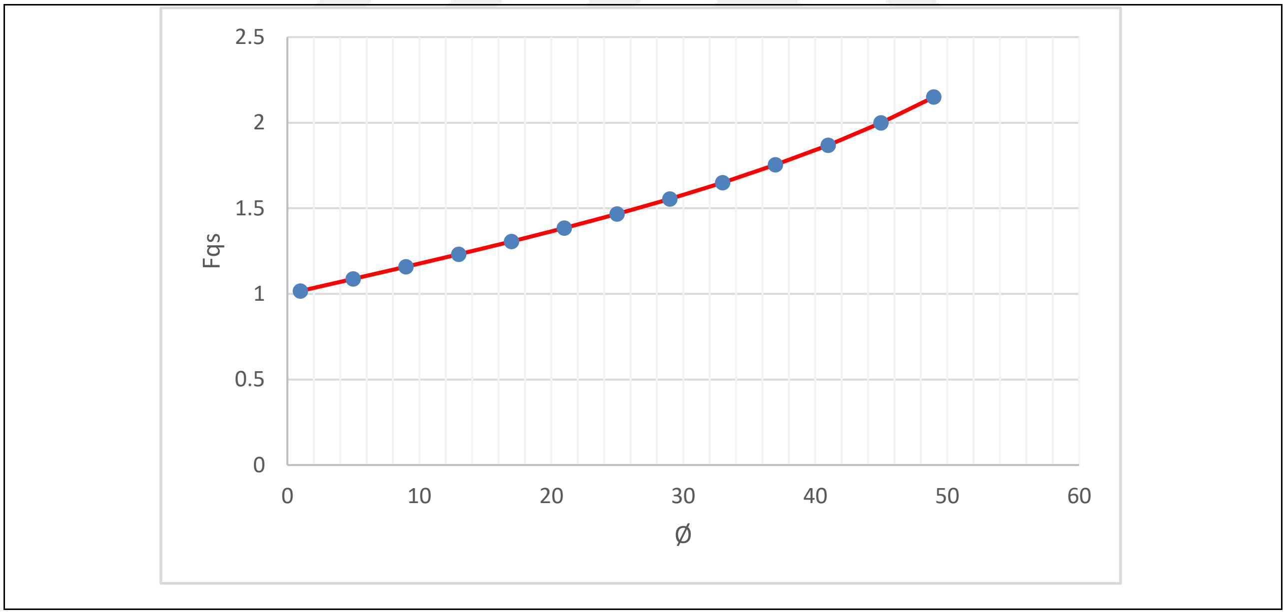

Figure 4.8: The Relationship of Ø and Fqs

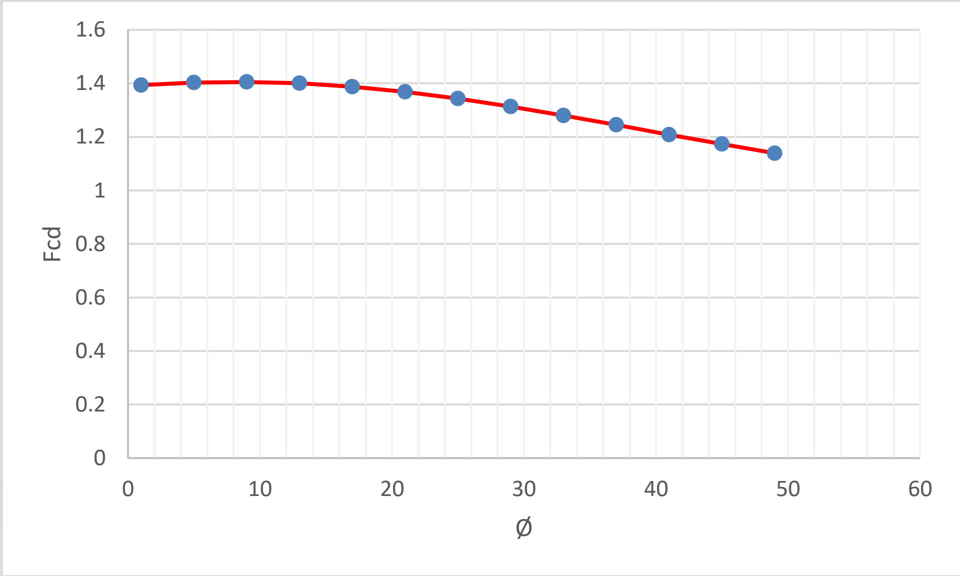

Figure 4.9: The Relationship of Ø and Fcd

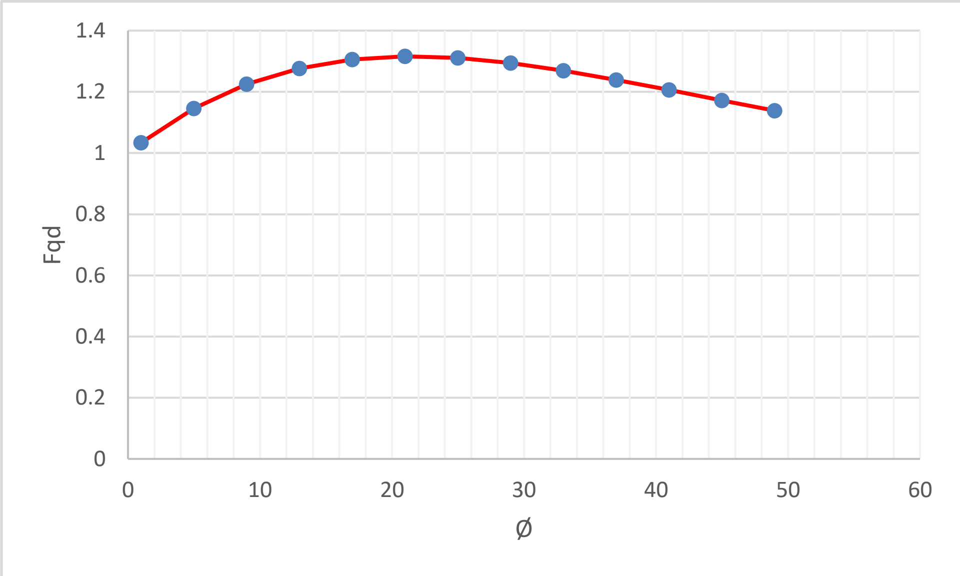

Figure 4.10: Relationship Of Ø and Fqd

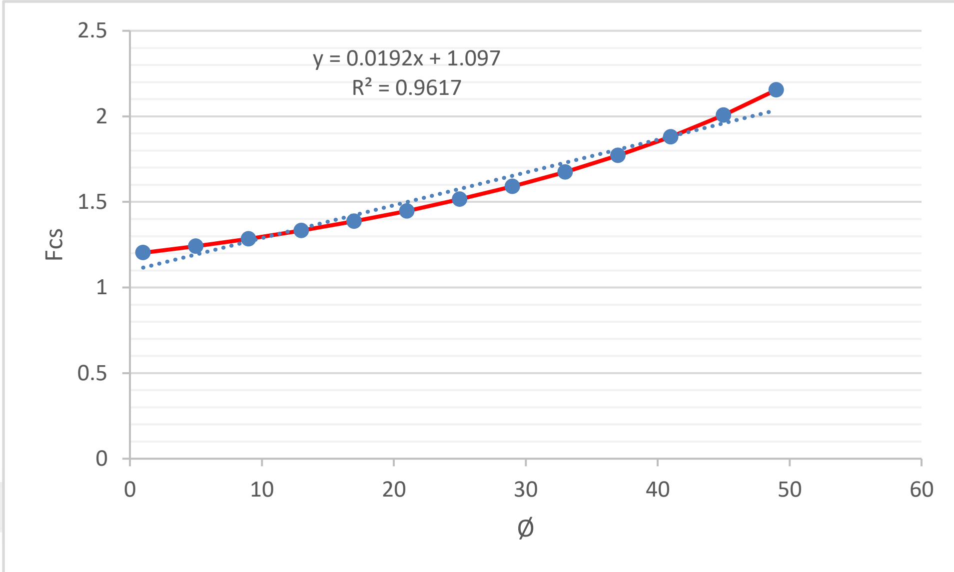

Figure 4.11: Curve Fitting For The Relationship of Ø and Fcs

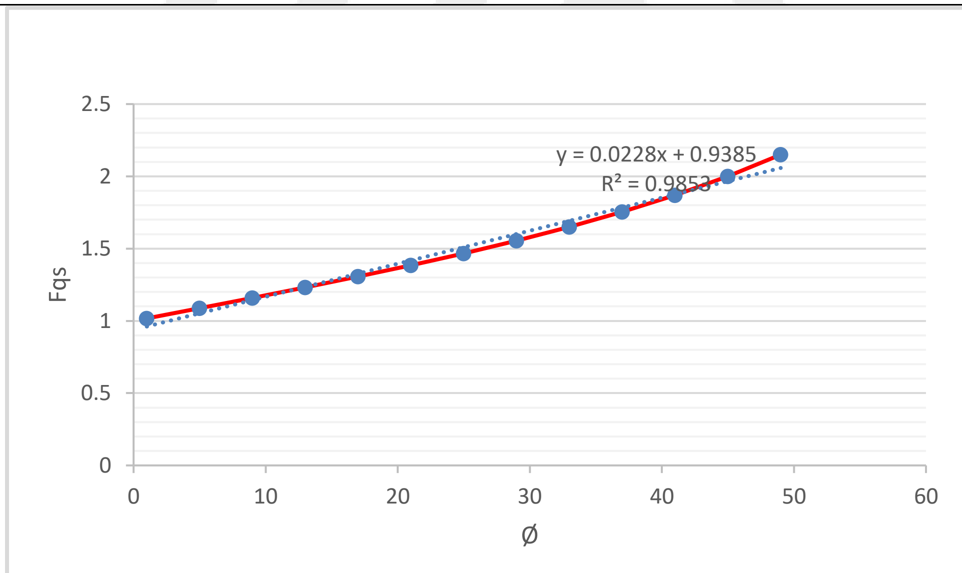

Figure 4.12: Curve Fitting For The Relationship of Ø and Fqs

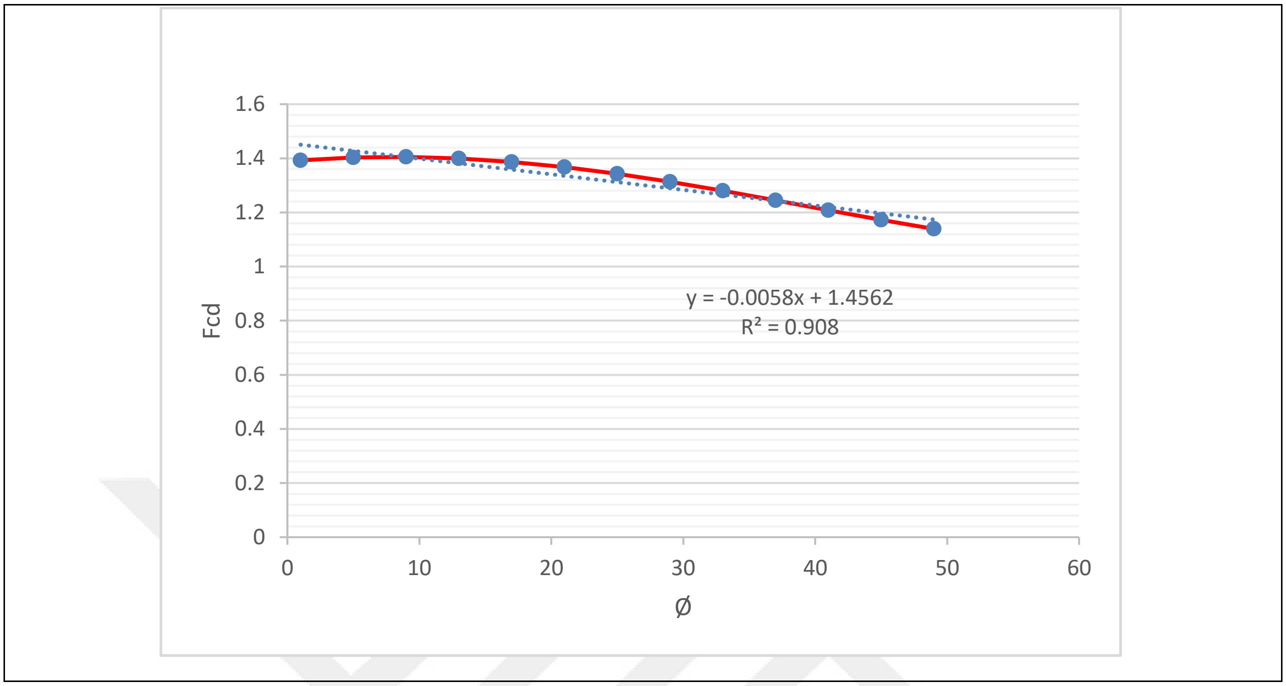

Figure 4.13: Curve Fitting For The Relationship of Ø and Fcd

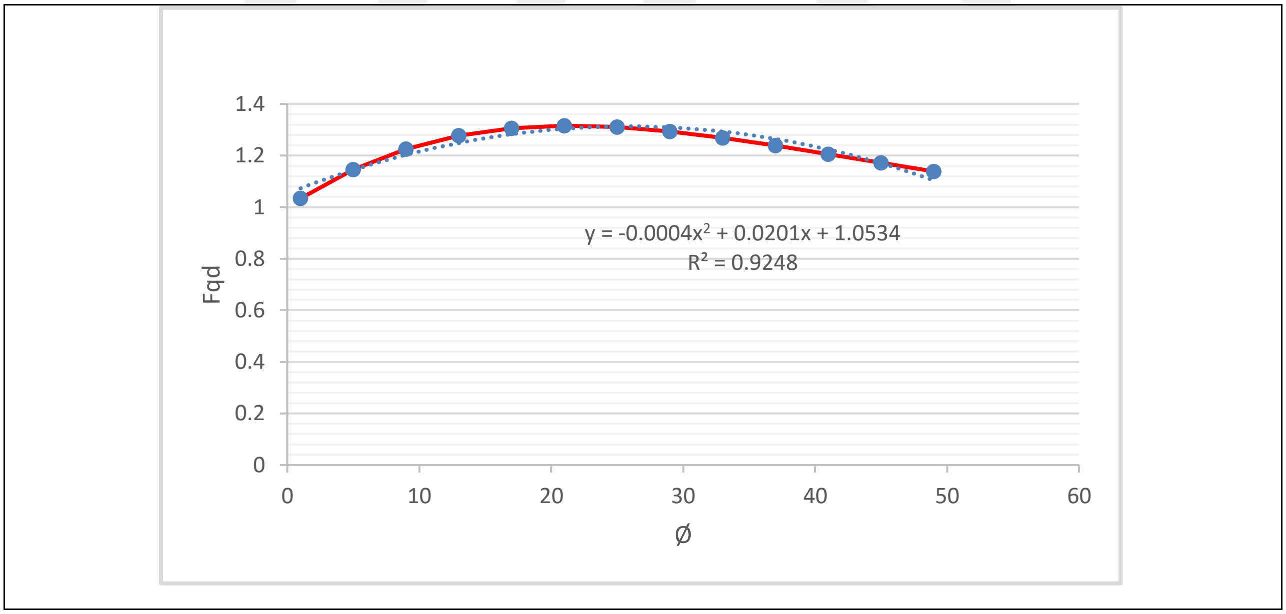

Figure 4.14: Curve Fitting For The Relationship of Ø and Fqd

Table 4.3: The Derived Equation By Curve Fittings For The Internal Friction Angle And Depth Factors And The Shape (B/L=1)

Term	Equation
Fcs	y = 0.0192x + 1.097
Fqs	y = 0.0228x + 0.9385
Fcd	y = -0.0058x + 1.4562
Fqd	y = $-0.0004x^2 + 0.0201x + 1.0534$

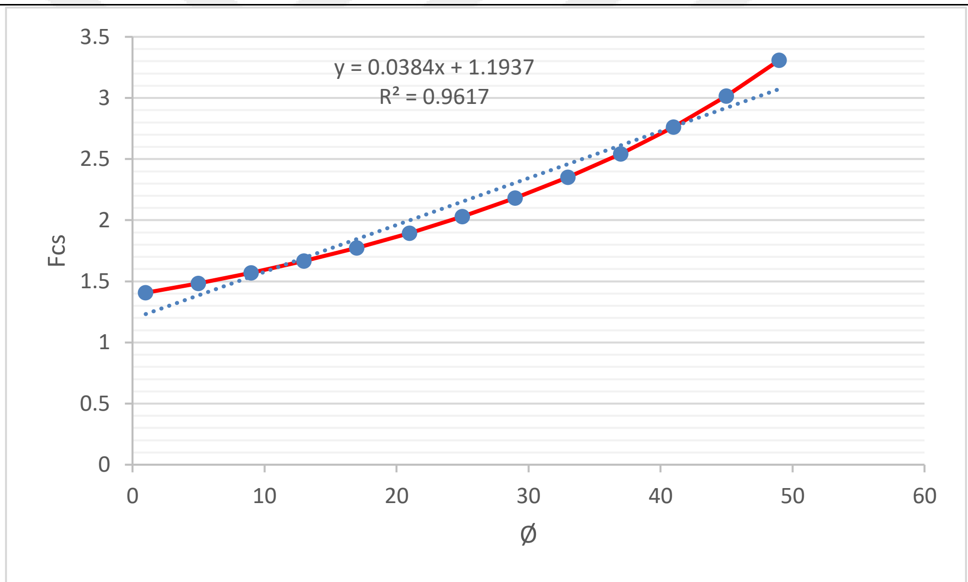

Figure 4.15: The Relationship of Ø and Fcs (B/L=2)

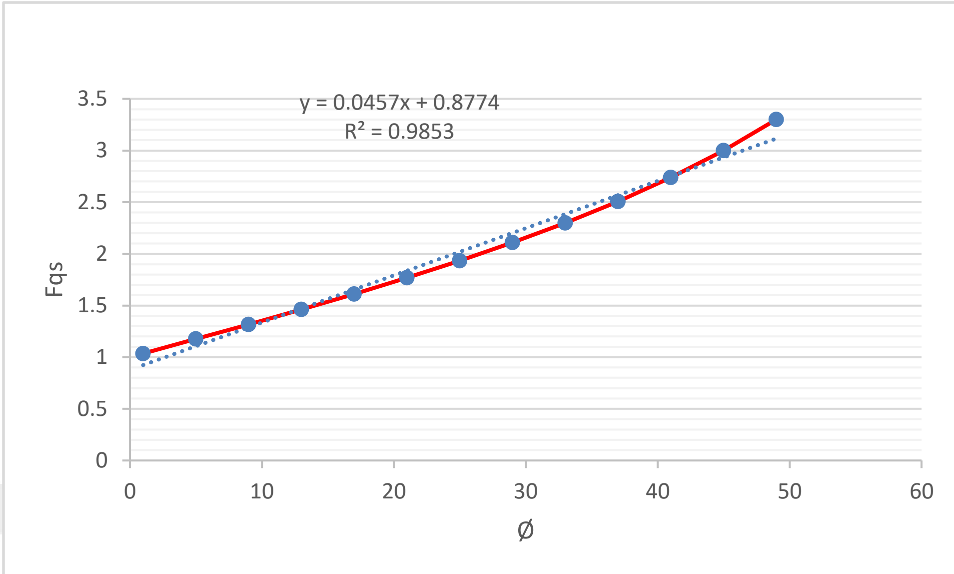

Figure 4.16: The Relationship of Ø and Fqs (B/L=2)

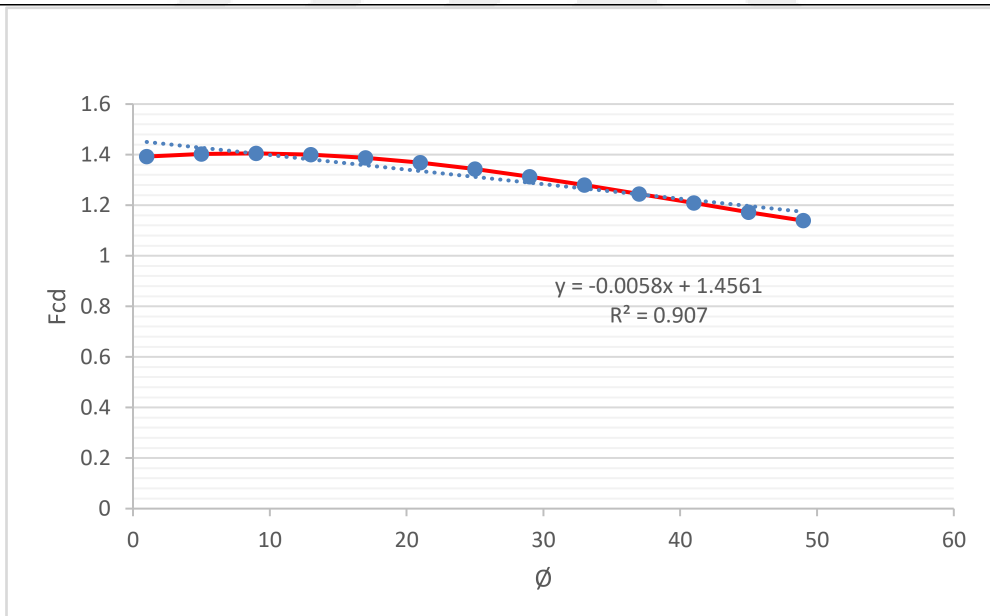

Figure 4.17: The Relationship of Ø and Fcd (B/L=2)

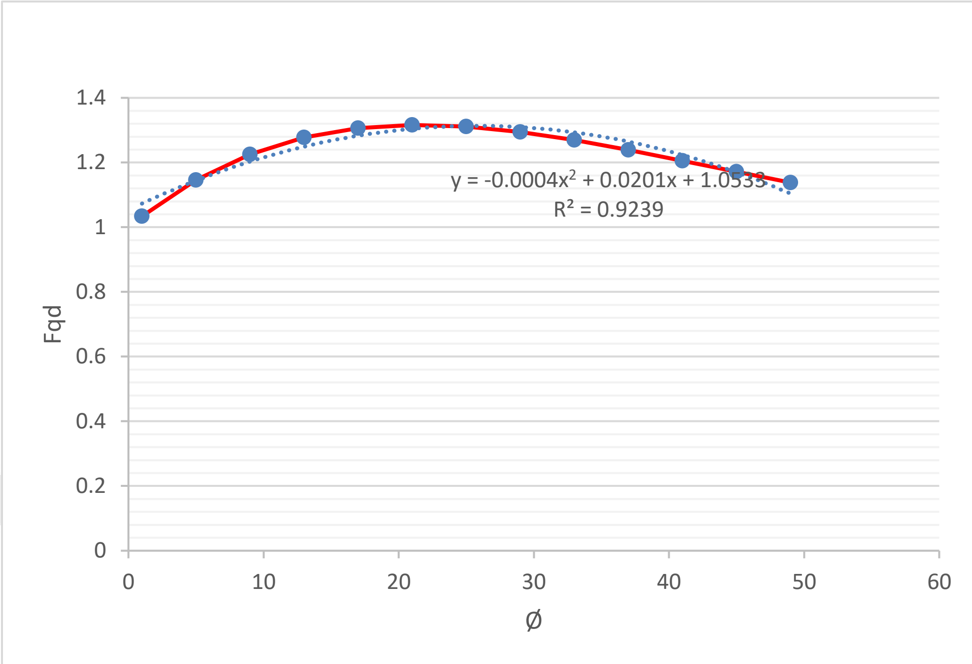

Figure 4.18: The Relationship of Ø and Fqd (B/L=2)

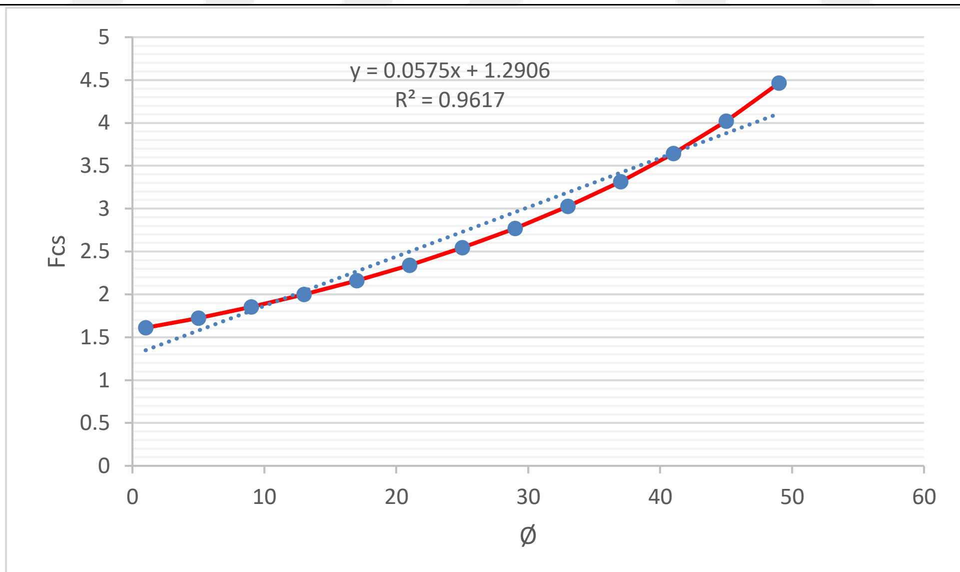

Figure 4.19: The Relationship of Ø and Fqs (B/L=3)

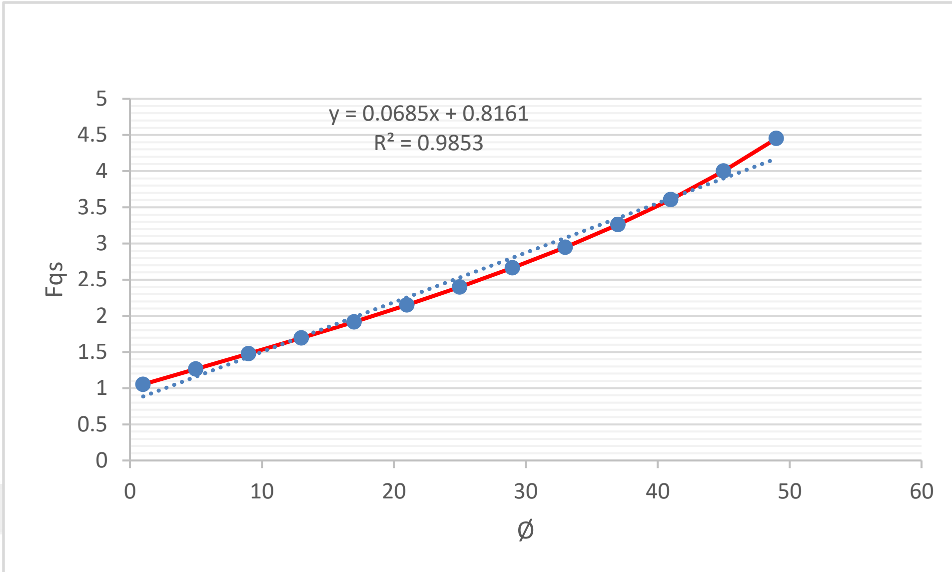

Figure 4.20: The Relationship Of Ø and Fqs (B/L=3)

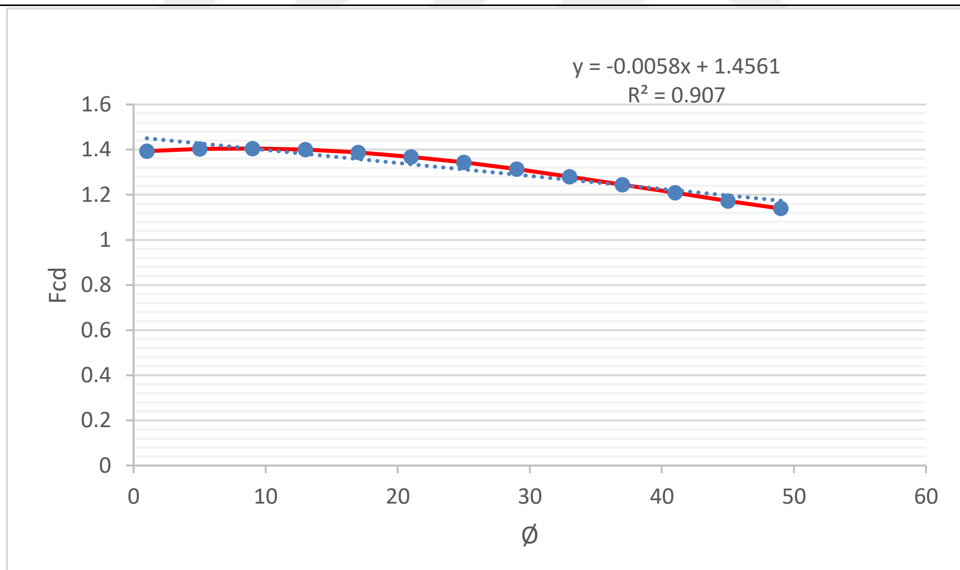

Figure 4.21: The Relationship of Ø and Fcd (Df/L=2)

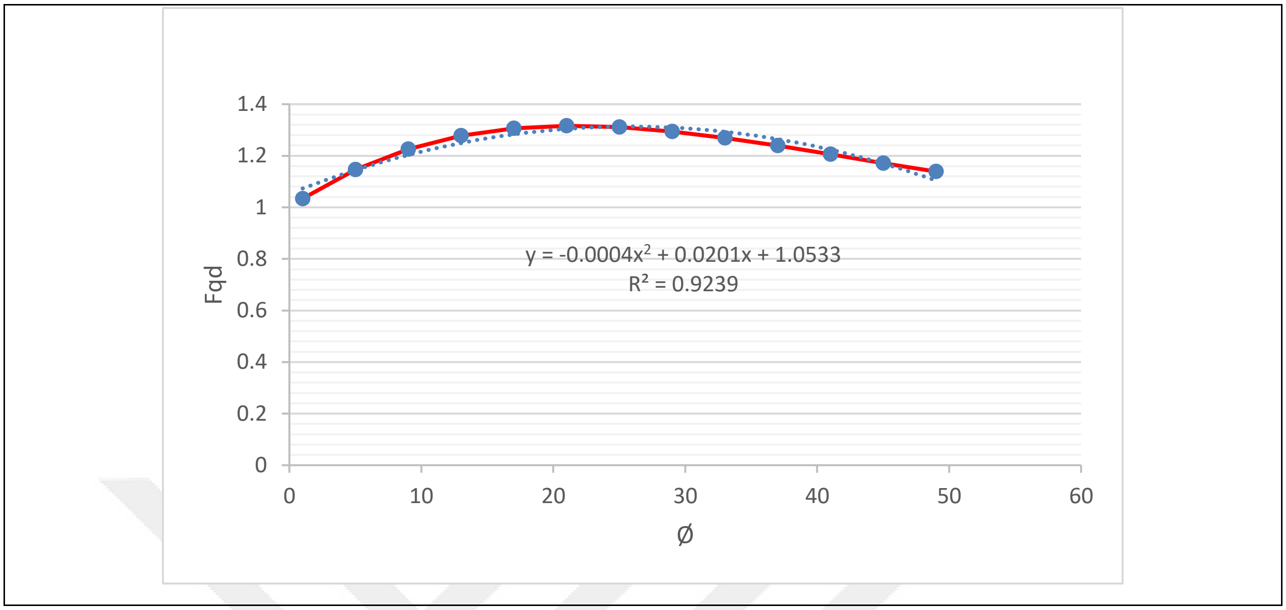

Figure 4.22: The Relationship of Ø and Fqd (Df/L=2)

B/L=0.5

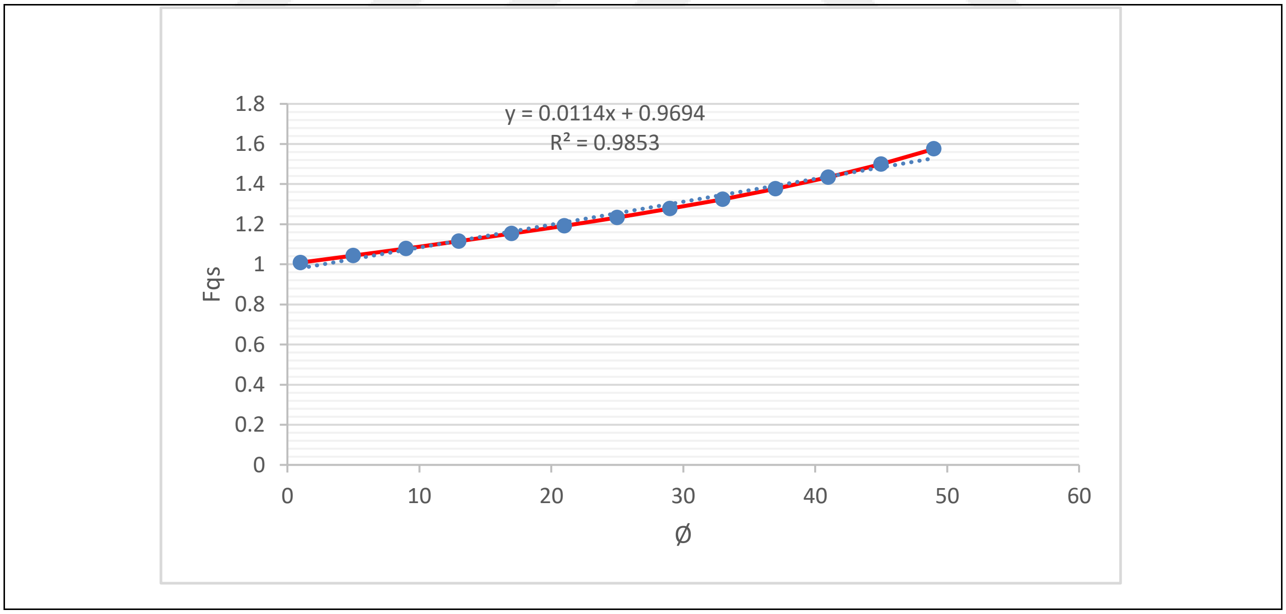

Figure 4.23: The Relationship of Ø and Fqs (B/L=0.5)

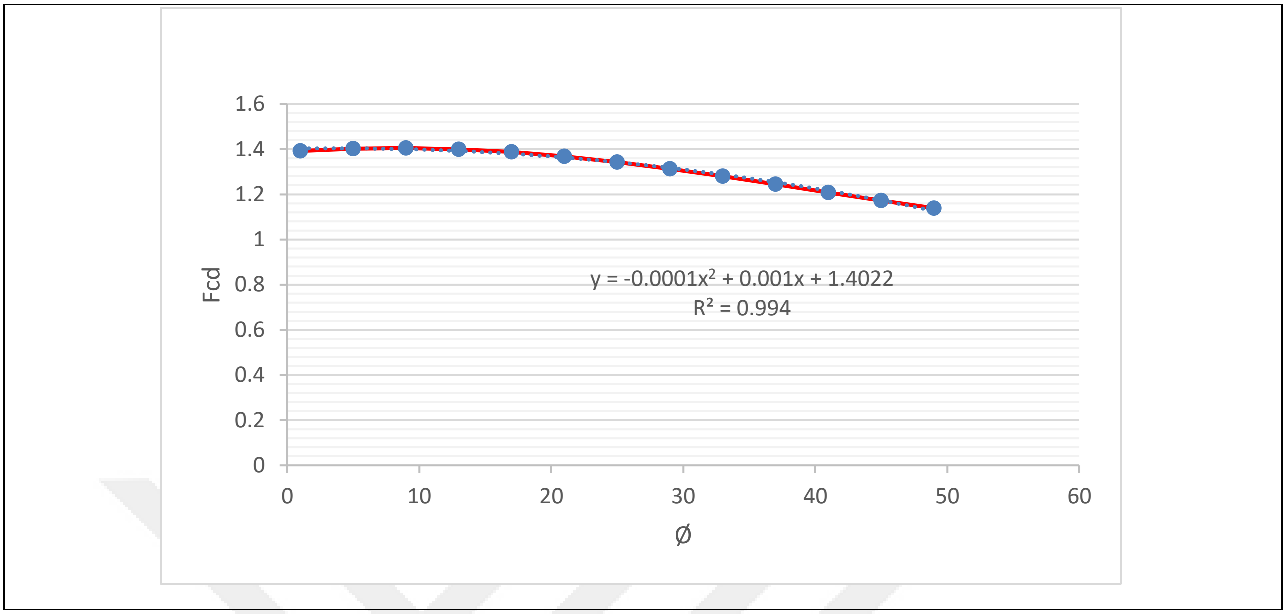

Figure 4.24: The Relationship of Ø and Fcd (B/L=0.5)

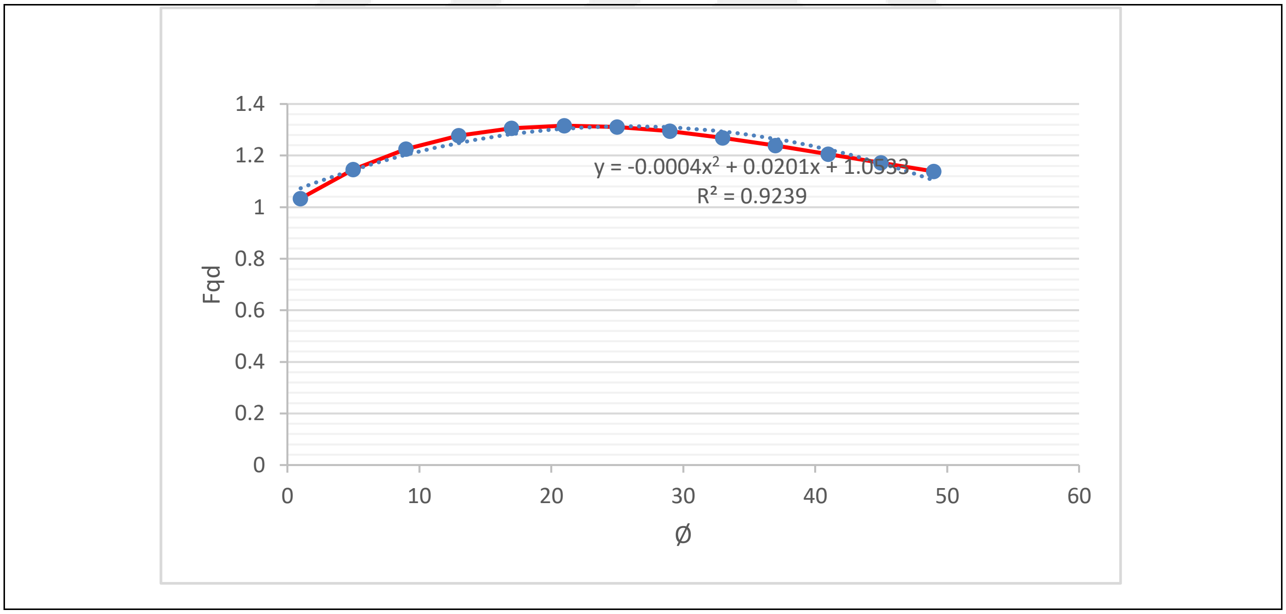

Figure 4.25: The Relationship of Ø and Fqd (B/L=0.5)

From the figures, the equation obtained was:

Table 4.4: The Derived Curve Fitting Equations For Friction Angle On Fcs Factors For Various B/L

limitation	Equations
B/L=0.5	y = 0.0096x + 1.0484
B/L=1	y = 0.0192x + 1.097
B/L=2	y = 0.0384x + 1.1937
B/L=3	y = 0.0575x + 1.2906

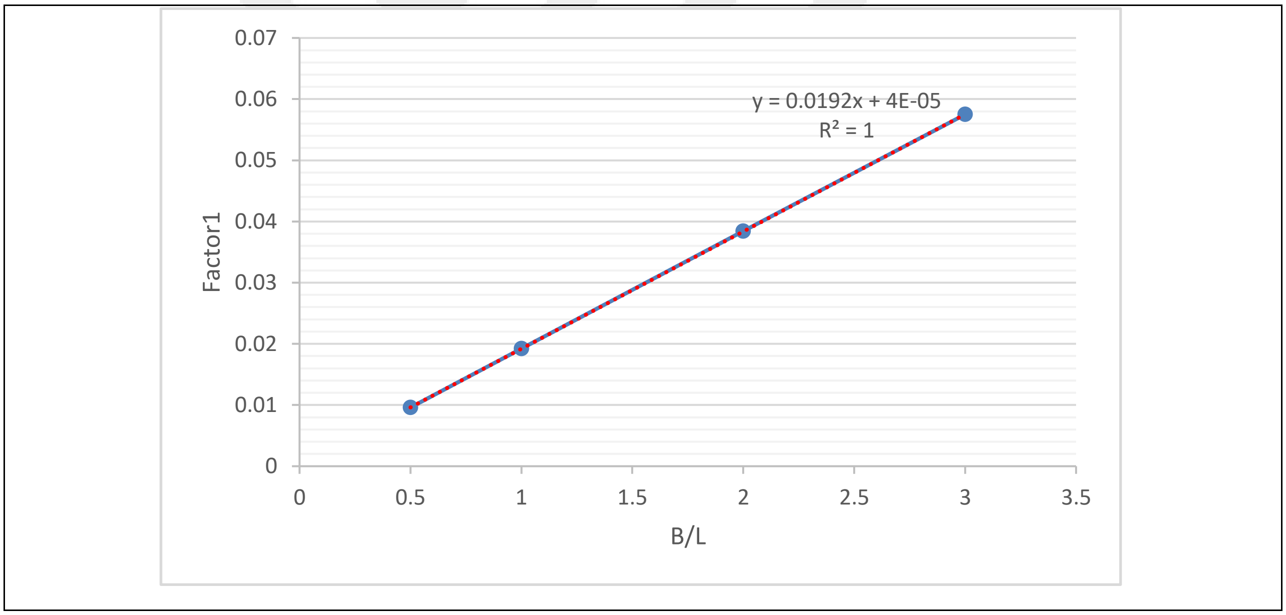

Figure 4.26 : The Correlation for B/L and first factor in the fitting equation of (Fcs)

If B/L =α1 then:

$$Fcs = 0.0192 * \text{Ø}\ \alpha 1 + 0.0969\ \alpha 1 + 1$$

Table 4.5: The Derived Curve Fitting Equations For Friction Angle On Fqs Factors For Various B/L

limitation	Equations
B/L=0.5	y = 0.0114x + 0.9694
B/L=1	y = 0.0228x + 0.9385
B/L=2	y = 0.0457x + 0.8774
B/L=3	y = 0.0685x + 0.8161

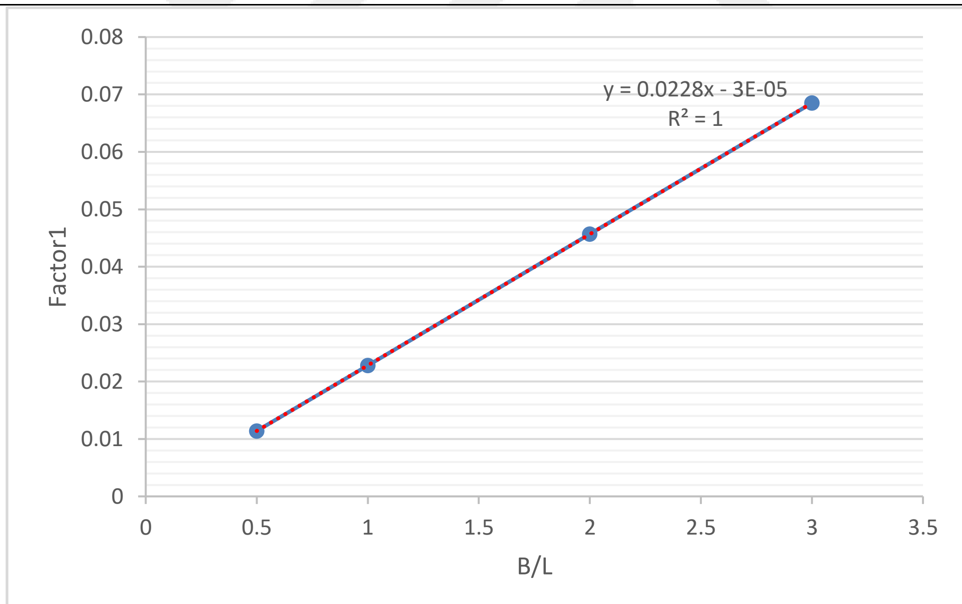

Figure 4.27: The Correlation For B/L And First Factor In The Fitting Equation Of (Fqs)

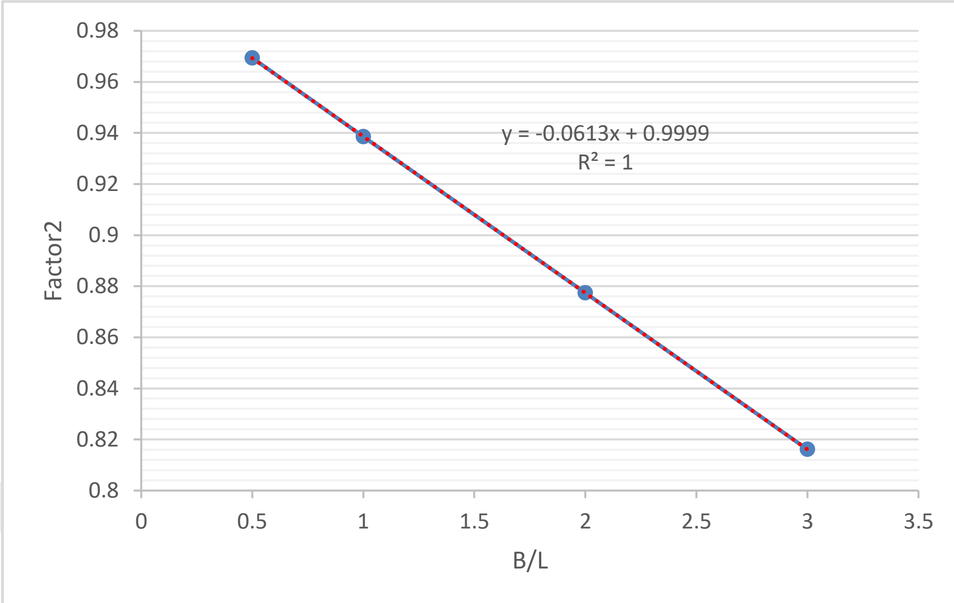

Figure 4.28: The Correlation For B/L And Second Factor In The Fitting Equation of (Fqs)

$$Fqs = 0.0228 * \text{Ø}\,\alpha 1 + 0.0613\,\alpha 1 + 1$$

Table 4.6: The Derived curve fitting equations for friction angle on Fcd factors for various Df/L

limitation	Equations
Df/L=0.5	y = -0.0058x + 1.4562
Df/L=1	y = -0.0058x + 1.4562
Df/L=2	y = -0.0058x + 1.4561
Df/L=3	y = -0.0058x + 1.4562

$$Fcd = -0.0058\, Ø + 1.456$$

Table 4.7: The Derived Curve Fitting Equations For Friction Angle On Fqd Factors For Various Df/L

limitation	Equations
Df/L=0.5	y = -0.0004x^2 + 0.0201x + 1.0533
Df/L=1	y = -0.0004x^2 + 0.0201x + 1.0534
Df/L=2	y = -0.0004x^2 + 0.0201x + 1.0533
Df/L=3	y = -0.0004x^2 + 0.0201x + 1.0533

$$Fqd = -\, 0.0201\, Ø + 1.0533 \qquad (4.4)$$

By merging the equations inside the qu equation, the resultant become:

$$qu = c'Nc\ \ Fcs\ \ Fcd\ \ + q\, Nq\ \ Fqs\ \ Fqd\ + \frac{1}{2}\, \gamma\, B\, Ny\ \ Fys\ \ Fyd \qquad (4.5)$$

$$qu = c'\, 3.7982\, e^{0.0758\, Ø}\ (0.0192 * Ø\, \alpha 1 + 0.0969\, \alpha 1 + 1)\, (-0.0058\, Ø + 1.4562) +$$
$$q\ \ 0.7819\, e^{0.1115\, Ø}\ (0.0228 * Ø\, \alpha 1 + 0.0613\, \alpha 1 + 1)\, (-\, 0.0201\, Ø + 1.0533) +$$
$$\frac{1}{2}\, \gamma\, B\ \ 0.1574\, e^{0.1674\, Ø}\ (1 - 0.4\alpha 1) \qquad (4.6)$$

By simplify the terms into parts:

$$P1 = c'\, e^{0.0758\, Ø}\ (0.07292\ \ Ø\, \alpha 1 + 0.368\ \ \alpha 1 + 3.7982) \qquad (4.7)$$

$$Fcq = -0.0058\, Ø + 1.4562 \qquad (4.8)$$

$$Fqd = -\, 0.0201\, Ø + 1.053 \qquad (4.9)$$

$$P2 = q\, e^{0.1115\, Ø}\ (0.01782\ \ Ø\, \alpha 1 + 0.0479\ \ \alpha 1 + 0.7819) \qquad (4.10)$$

$$P3 = \gamma\, B\ \ e^{0.1674\, Ø}\ (0.0785 - 0.0314\, \alpha 1) \qquad (4.11)$$

$$qu = Fq\, P1 + Fqd\, P2 + P3 \qquad (4.12)$$

Table 4.8: The Check Of The Satisfying For The Calculated And Derived Equation

Ø	qu calculated	qu derived	Correlation factor
1	8.48	7.40	1.15
5	16.46	13.34	1.23
9	30.10	22.89	1.31
13	53.11	37.96	1.40
17	91.64	61.27	1.50
21	156.18	96.57	1.62
25	265.26	148.80	1.78
29	452.92	224.12	2.02
33	784.78	329.38	2.38
37	1394.46	470.80	2.96
41	2572.91	650.82	3.95
45	4847.94	862.02	5.62
49	10189.98	1076.24	9.47

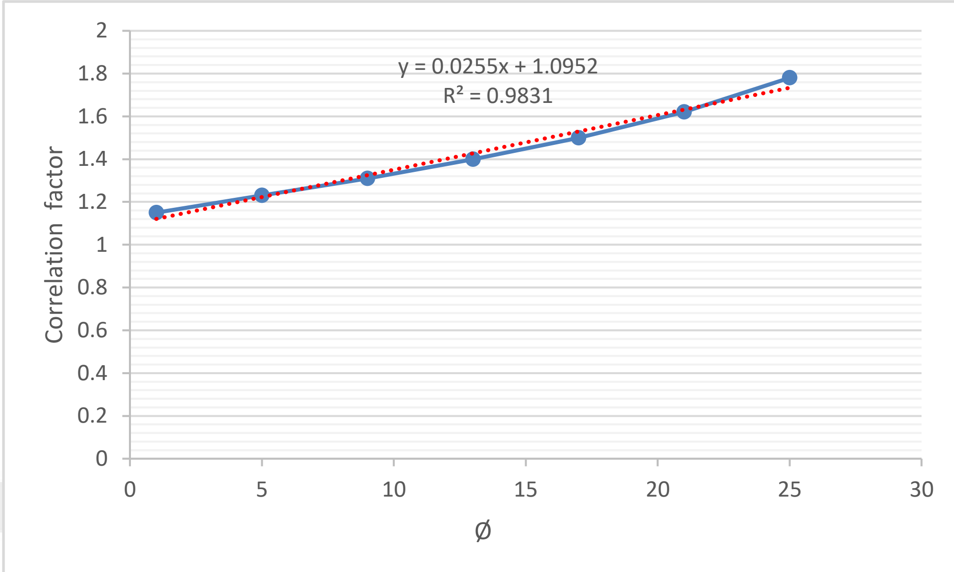

Figure 4.29: The Relationship For Ø And The Correlation Factor For The Bearing Capacity Derived Equation for (Ø $\leq$ 25)

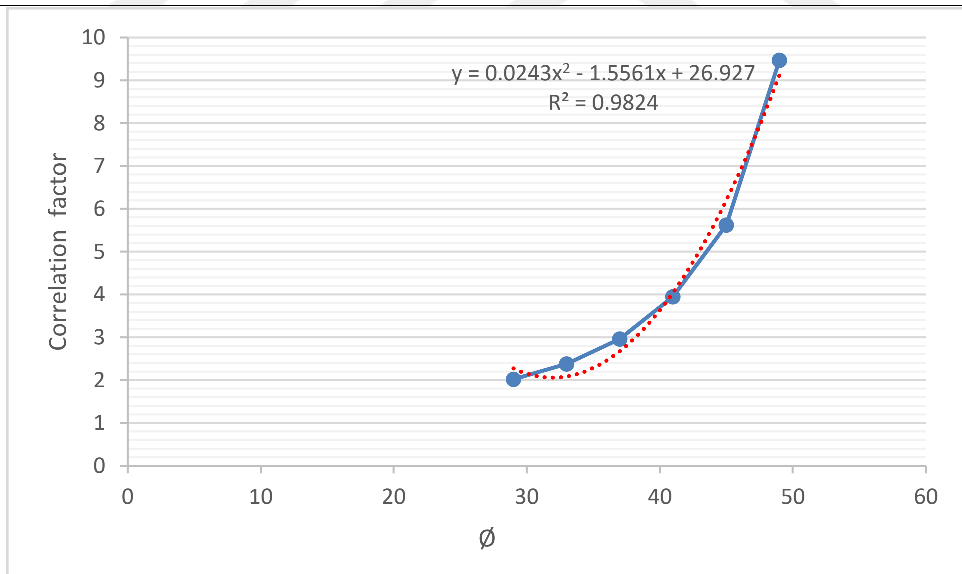

Figure 4.30: The Relationship For Ø And The Correlation Factor For The Bearing Capacity Derived Equation (Ø>25)

$$qu = \beta 1(Fq\ P1 + Fqd\ P2 + P3) \quad (4.13)$$

For Ø ≤ 25:

$$\beta 1\ =\ 0.0255\ Ø\ +\ 1.0952 \quad (4.14)$$

For Ø > 25:

$$\beta 1 =\ 0.0243\ Ø^{2}\ -\ 1.5561\ Ø +\ 26.927 \quad (4.15)$$

Table 4.9: The Results Of Correlation For The Calculated And Derived Equation

Ø	qu calculated	qu derived	Calculated/derived
1	8.48	8.29	1.023
5	16.46	16.31	1.009
9	30.10	30.32	0.993
13	53.11	54.16	0.981
17	91.64	93.66	0.978
21	156.18	157.47	0.992
25	265.26	257.83	1.029
29	452.92	501.22	0.904
33	784.78	671.40	1.169
37	1394.46	1232.55	1.131
41	2572.91	2587.16	0.994
45	4847.94	5266.93	0.92
49	10189.98	9710.23	1.049

4.2 SIMULATION THE STRESSES BY ANSYS

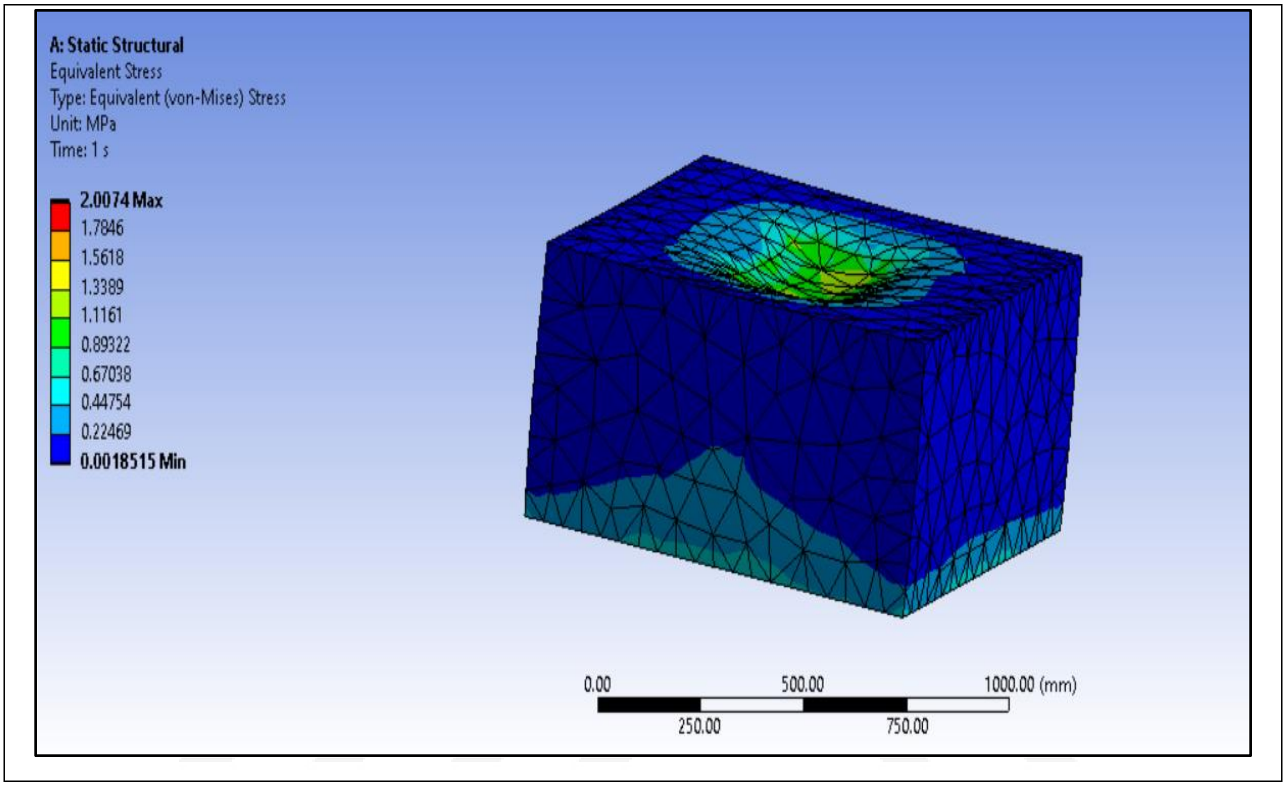

Figure 4.31: Equivalent Stress In Soil Body By The Foundation Loading

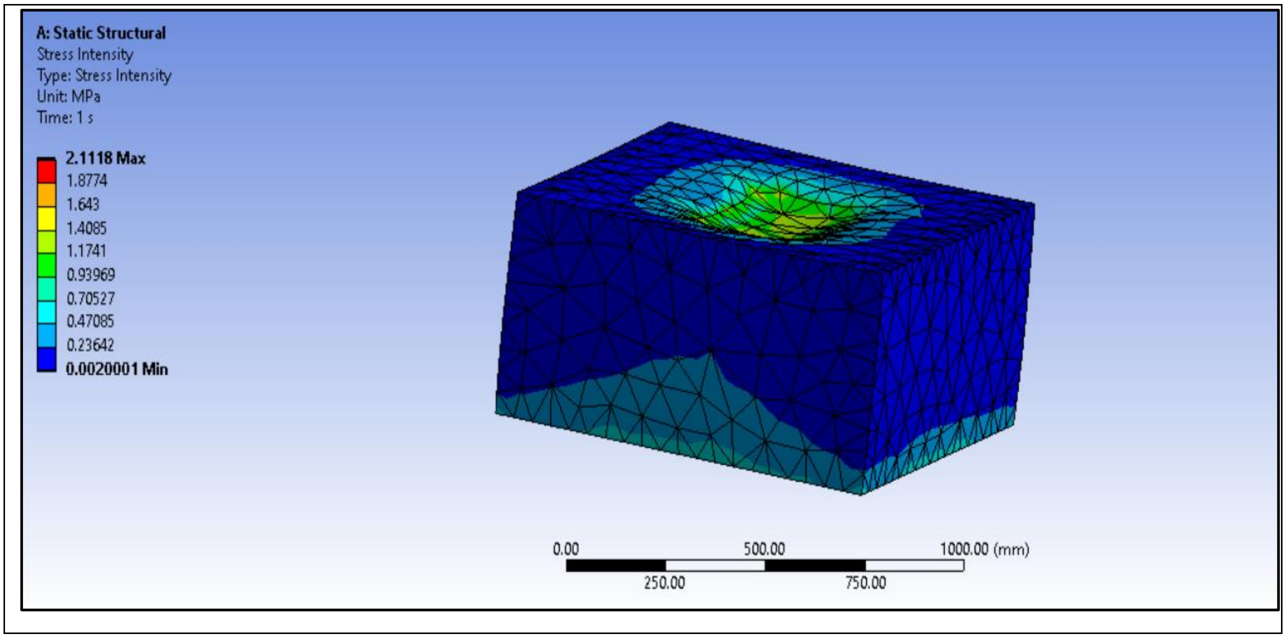

Figure 4.32: Intensity Of Stress In Soil Body By The Foundation Loading

5. DISCUSSION AND CONCLUSIONS

5.1 CONCLUSIONS

The analysis of bearing capacity of soil under shallow foundations was made inside the study by using the equation of general bearing capacity based on Terzaghi theory. The study investigated the effect of each factors in the equation on the output capacity reached. The factors were cohesion, effective stress, and unit weight of soil, width or the depth of foundation, elevation of water table, friction angle, and depth of foundation). The analysis was made for each factors to find out how these factors contribute directionally or inversely to the barning capacity achieved. The study examined the effect of friction angle on the bearing factors (Nq, Nc, and Ny). The effect then converted under curve fitting process to get the possible equations that represented the impact of the angle for various soil types. The study found that the best relationship for the friction angles and the bearing factors was in exponential form. The study found also the effect of the angle of friction for the shape factors (Fcs, Fqs, and Fys) was indexed by the fitting techniques in linear form while for depth factors(Fcd, Fqd, and Fyd) was indexed mostly by the fitting techniques in polynomial form. The study made these processes for all the parts of the general bearing equation to achieve the derived equation that can be simplify the reaching of the bearing capacity of soil for the design purposes. The equations that derived were:

$$P1 = c' \, e^{0.0758\,\emptyset} \; (0.07292 \;\; \emptyset \, \alpha 1 + 0.368 \;\; \alpha 1 + 3.7982) \tag{5.1}$$

$$Fcq = -0.0058\,\emptyset \; + \; 1.4562 \tag{5.2}$$

$$Fqd = -\,0.0201\,\emptyset + \; 1.0533 \tag{5.3}$$

$$P2 = \; q \, e^{0.1115\,\emptyset} \; (0.01782 \;\; \emptyset \, \alpha 1 + 0.0479 \;\; \alpha 1 + 0.7819) \tag{5.4}$$

$$P3 = \gamma \, B \;\;\; e^{0.1674\,\emptyset} \; (0.0785 - 0.0314 \, \alpha 1) \tag{5.5}$$

$$qu = Fq \; P1 + Fqd \; P2 + P3 \tag{5.6}$$

The simulation for the cases was implemented by using ANSYS workbench program, the transferring of the stresses from the elevation of contacting between the foundation and the soil toward the deepest level of the soil was showed by the 3d images in inclined directions as obtained by the analysis theory.

5.2 FUTURE WORK

The analysis of other kinds of foundations like sheet piles and raft foundations can be used for future ideas. The linking between the soil capacity of soil and the quantities analysis of multi-story buildings can be adopted for coming studies as effective way to improve the design procedures from the architectural views to the civil engineering design concepts. The feasibility of using number of soil layers and the transfer of stresses among them can be taken as other ideas for future studies.

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