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To Study the Behaviour of Single Pile Foundation Under Vertical Loading using Geo 5''

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Abstract: *The objective of the project is to analyze a pile foundation and determine it's load bearing capacity by static method and a software and compare the results. This project includes the analysis of pile formed on black cotton soil atsite of the "Galaxy Sky Residency" Miraj.. The calculations were carried out using the commercial software GEO5 from FINE Inc. This software computes the load-displacement curve on the pile head and the distribution of normal andshear forces along the shaft. The shear behavior of the pile-soil interface is de-scribed according to a modified Mohr- Coulomb's theory. This paper also focuses on the de-termination of parameters of strength (angle friction and cohesion)and settlement (Young modulus) for deep foundation. The use of GEO4 for foundation design is explained in details herein.*

Keywords: bearing capacity, Commercial software, black cotton soil, pile-soil interface

I. INTRODUCTION

Generally, high rise/tall buildings are supported by pile foundations at sites encountering poor soil conditions at shallow depths. Structures like transmission towers, mooring systems for surface or submerged ocean platforms, tall chimneys, jetty structures, etc. are also often supported by pile foundations. These structures are subjected to large lateral loads and overturning moments due to wind, waves, or both, in addition to vertical compressive load. As aresult, the piles supporting these structures have to resist large lateral and uplift loads and moments [1]. In most cases, these loads (compressive, lateral, and uplift) and moments act on the piles simultaneously.There are many well- established theoretical methods available to evaluate the pile behavior under different independent loadings, viz, vertical compressive, vertical-uplift, and lateral loadings [2].

When the soil at shallow depth is not capable of supporting a structure, deep foundations are required to transfer the loads to deeper strata. If a firm stratum is so deep that it cannot be reached by open excavation, the deep foundationwill be adopted [3].

The most common types of deep foundations are Piles, Piers and Caissons. The mechanism of transfer of the load to the soil is essentially the same in these types of foundations. When piles and raft are both equal in cost, then piles are preferable to rafts as the settlement for piles is considerably less than that of a raft [4].

Economy in pile foundation is achieved by designing the piles of suitable diameters such that the sum of safe capacity of piles under a column should be almost equal to the load coming on the column. In one pile group there should be preferably only one diameter of piles. In a building, diameter of piles may vary under various columns depending on the magnitude of load being carried by the columns.This paper presents the Comparison results between analytical and numerical method and also attempts to study the sheet pile behavior by using a two-dimensional finite element model [5].

II. RELEVANCE OF THE WORK

From above literature survey, work has been done on "GEO 4" software. And by comparing the result on GEO4 software and manual calculation there is 36% difference in result. Also the tests conducted are Unit weight, Cohesion of soil, Adhesion of soil, bearing capacity coefficient only. Also they assume soil bearing capacity coefficient as per existing structures present in area, or by existing soil strata in particular area.

III. PROPOSED WORK

The study of the project is to analysis of a pile foundation and determine its load bearing capacity by static analysis method (manually) and by a software and compare the results between manual analysis and software analysis. This project includes the analysis of pile foundation on black cotton soil at site. The calculations were carried out using the commercial software GEO5 from FINE Inc. This software computes the load-displacement curve on the pile head and the distribution of normal and shear forces along the shaft. The shear behavior of the pile and soil interface is described according to a modified Mohr-Coulomb's theory. And to overcome the previous tests results we use GEO 5 software. And carryout following tests.

- Type of soil
- Unit weight
- Cohesion of soil
- Adhesion of soil
- Bearing capacity coefficient
- Shear strength
- Angle of skin friction
- Coefficient of lateral stress
- Pile base bearing capacity
- Critical depth
- Bearing capacity factors

Objective

- To carry out soil classification and study of various properties of soil.
- To find out Load carrying capacity of a pile foundation under vertical loading.
- To find out bearing capacity of soil.
- To estimate and calculate the factor of safety using GEO5 Software.
- GEO5 Software is used to construct and verify spread footing foundations using input parameters

Scope

- It is beneficial to find out load carrying capacity of pile foundation on large extent.
- It gives quick results.
- This software is user friendly and doesn't require any special training.
- It is low cost modular system.

Proposed Methodology :-

- Site selection.
- Site study and collection of sample .
- Soil stratification and classification.
- Testing of soil sample

Calculation of required soil properties (carrying out test on soil sample if essential).

- Type of soil
- Unit weight
- Cohesion of soil
- Adhesion of soil
- Bearing capacity coefficient
- Shear strength
- Angle of skin friction
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- Pile base bearing capacity
- Critical depth
- Bearing capacity factors

Use GEO 5 Software and carry out analysis using the NAVFAC DM 7.2 method by filling of all input dataand collected properties in previous step.

Comparison between the result we get from GEO 5 software and manual calculation.

IV. CONCLUSION

The design vertical bearing capacity of a centrally loaded pile R_C (KN) consists of the sum of the skin friction R_S and the resistance on pile base R_b . To meet the condition for reliability, its value must be higher than the magnitude of the design load V_d (KN) acting on the pile head

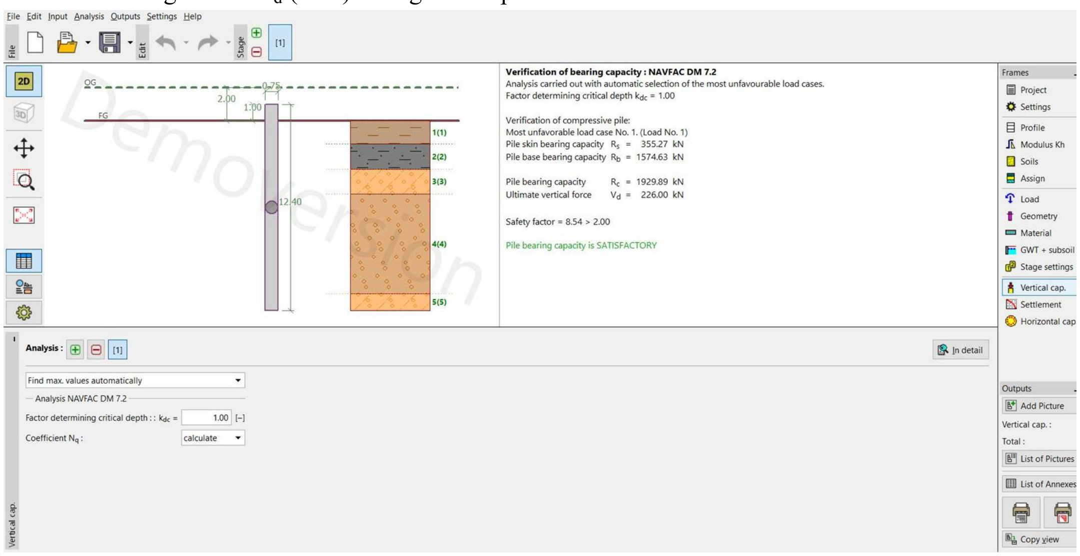

Figure 5

The total vertical bearing capacity of a centrally loaded single pile R_C is higher than the value of the design load V_d acting on it. The fundamental reliability condition for the ultimate limit state is met; the pile design is therefore satisfactory.

Results by manual method

Static method formula – $Q_U = Q_B + Q_S$

= 1188+766.17

= 1954.17 KN

Comparison between results

Load carrying capacity of pile Manual calculations = **1954.17 KN**

GEO5 calculations =**1929.89 KN**

Difference between results = **4.23 %**

Summary/Finding

Depending on the number of topics, this topic number may change from 5 to something else. Briefly explain thesummary of your project here.

Conclusions

User friendly software –

GEO 5 software isuser friendly ,any special training is required .

Elimination of manual error –
By use software errors or deviation of results due manual methods can be reduced so that results get more precise.
Availability of other parameters -
Software gives load vs settlement curve which eliminates plate load test for finding out settlement of pile foundation. Software also provides bending moment and shear force diagram so that critical section can be easily examined.

Time saving –
If follow regular method of calculation of vertical load carrying capacity of pile by static approach then laboratory test must be carried out to find parameters such as unconfined compressive strength , shear strength parameters (c and phi values). But,in case of software only we need to provide soil classification so that other tests gets eliminated and saves time. Results get available earlier compared to manual .
Economy –
Initial investment is high but low operating cost.
Scope for future work
Addition of parameters –
More parameters should be considered for accurate classification of soil.
Unconfined compressive strength and saturated unit weight –
There should be provision for entering unconfined compressive strength & saturated unit weight.

SOFTWARE INTRODUCTION
In this chapter, results and discussions related to the project work are to be discusses. These will be in accordance withthe work done in previous chapter

Calculation By Software-
General problem specification is described in the previous chapter .
All analyses of the vertical load-bearing capacity of a single pile shall be carried out in compliance with requirements of Indian Standard. The resultantof loading components N_1 $My,_1$ $Hx,1$acts at the pile headlevel.

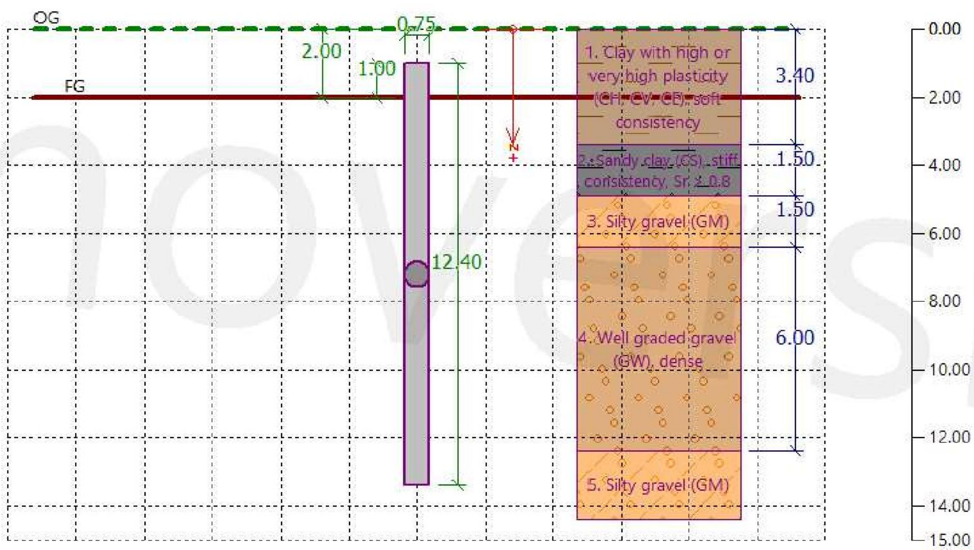

Figure 6: Pile geometry and Soil stratification Detail

We will apply the GEO 5 – PILES program to the analysis of this problem. In the textbelow we will describethe solution to this example step by step.
In this analysis we will assess a single pile using various analytical calculation methods.

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(NAVFAC DM 7.2, EFETIVE STRESS and CSN 73 1002) and will focus ourselves on the ***input parameters*** which influence overall results.

Specification definition:
We click on the Select Settings button (at the bottom left of the screen) in the Settings frame and then we select the “Indian-Standard” analysis setting. Further we set
the method of the analysis of vertical load-bearing capacity of a pile using *the analytical solution.* In our case we will assess the pile in ***undrained conditions***.
We will use the NAVFAC DM 7.2 method, which is set by default for this analysissetting, for the initial assessment of the pile (see the fig 6)

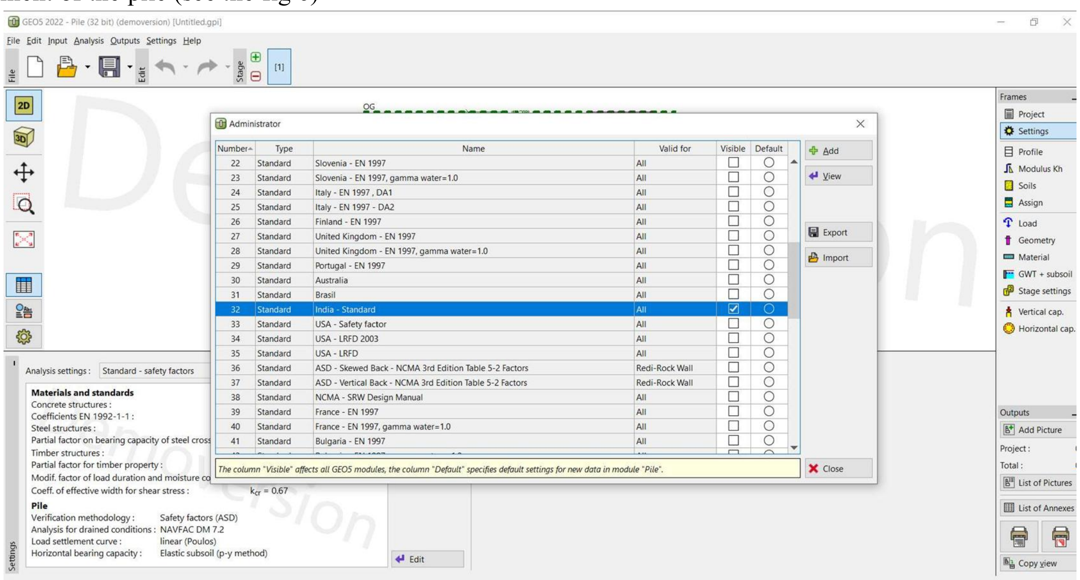

Figure 7: Analysis Settings Chart

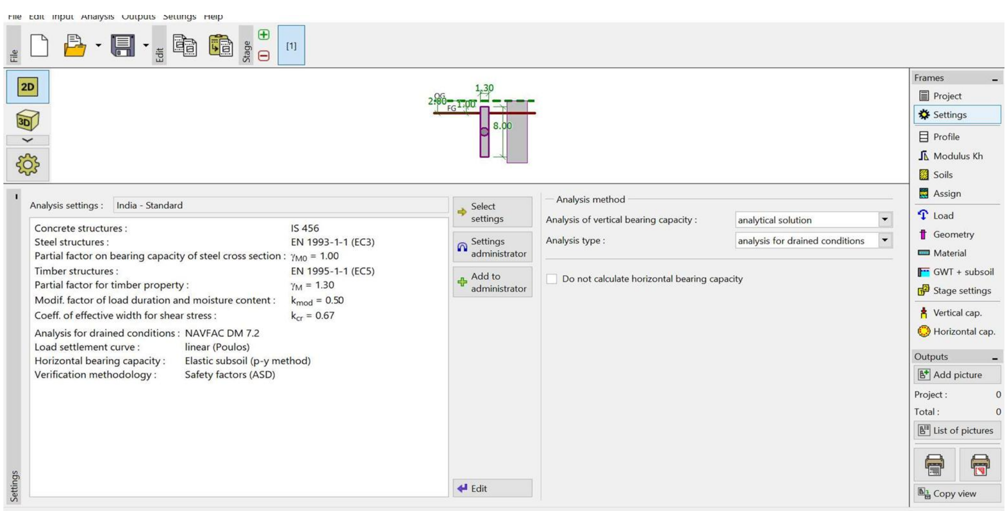

Figure 8: Software Analysis Settings Window

In the next step we will specify the geological profile. We will leave theModulus $K_h$out, because of the factthat in this analysis we don´t analyze the lateral load. In our caseit therefore doesn’t matter which value is specified for the Dispersion angle ß because this parameter will not at all affect the resulting value of the vertical load-bearing capacity of the pile.

Further we will define the other parameters of soils required for the analysis and assign them to the profile. The NAVFAC DM 7.2 method requires that the soil type is defined first,i.e. whether it is a cohesive or cohesion less soil layer. All below-listed parameters influence the magnitude of skin friction Rs kN.

Soil (Soil classification)	Unit weight $\gamma\ [kN/m^3]$	Angle of internal friction $\varphi_{ef}\ [°]$	Cohesion of soil $c_{ef}\ /\ c_u\ [kPa]$	Adhesion factor $\alpha\ [-]$	Bearing capacity coefficient $\beta_p\ [-]$
CS – Sandy clay, firm consistency	18.5	24.5	- / 50	0.60	0.30
S-F – Sand with trace of fines, medium dense soil	17.5	29.5	0 / -	-	0.45

Table no 6: Table with the soil parameters – Vertical bearing capacity (analytical solution)

For the 1st layer, which is considered as undrained cohesive soil (clayey sand), we must in addition specify the total soil cohesion (undrained shear strength) cu kPa and the so-called adhesion factor . This factor is determined relative to the soil consistency, pile material and total soil cohesion (for more details see table 6).

For the 2nd layer, which is considered as Clay with high or very high plasticity (CH,CV,CE) stiff consistency,we must in addition specify the angle of skin friction δ, which depends on the pile material. Further we must define the coefficient of lateral stress K_h, which is affected by the type of loading (tension – pressure) and by the pile installation technology.

And so on input the soil layers and specify their consistency.

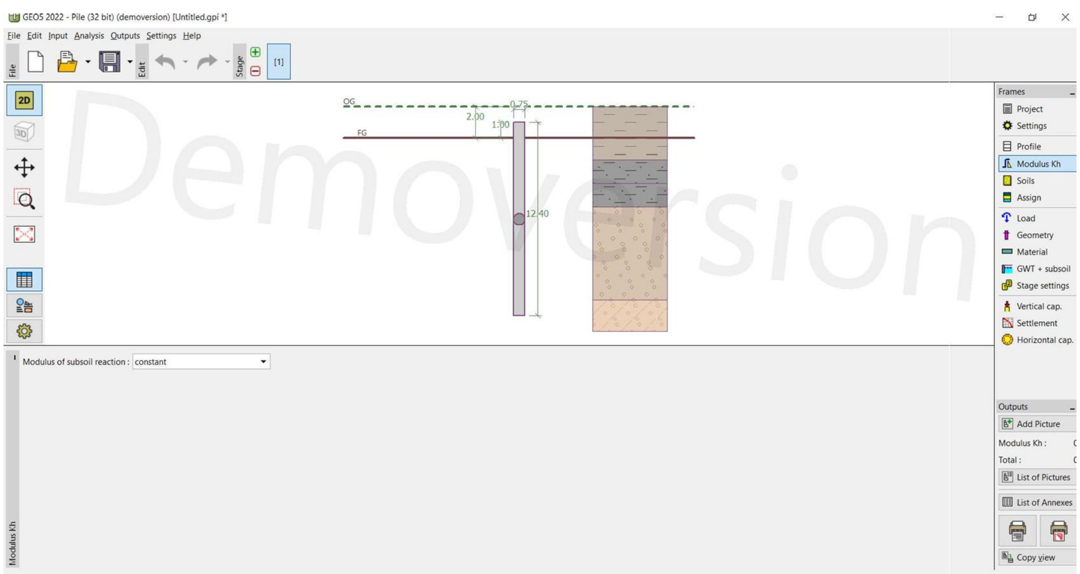

Figure 9:Modulus of Subsoil Reaction

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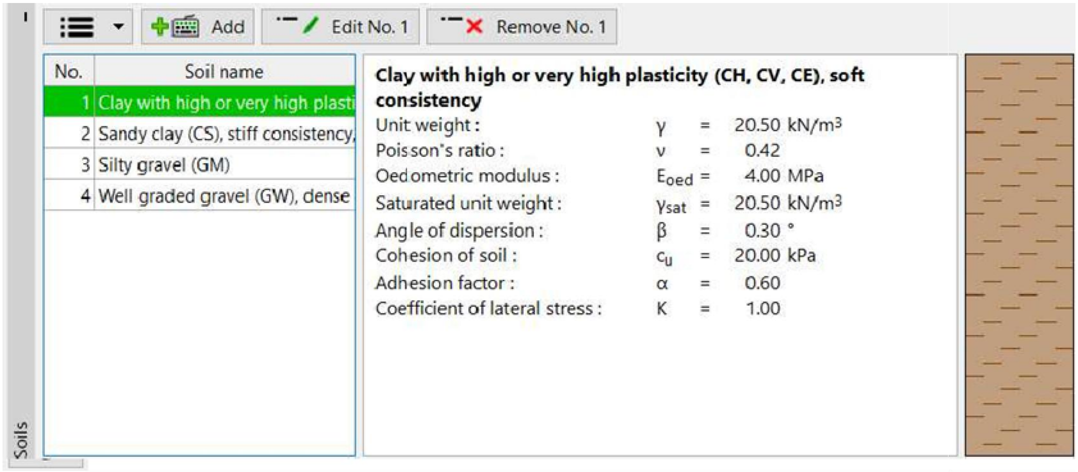

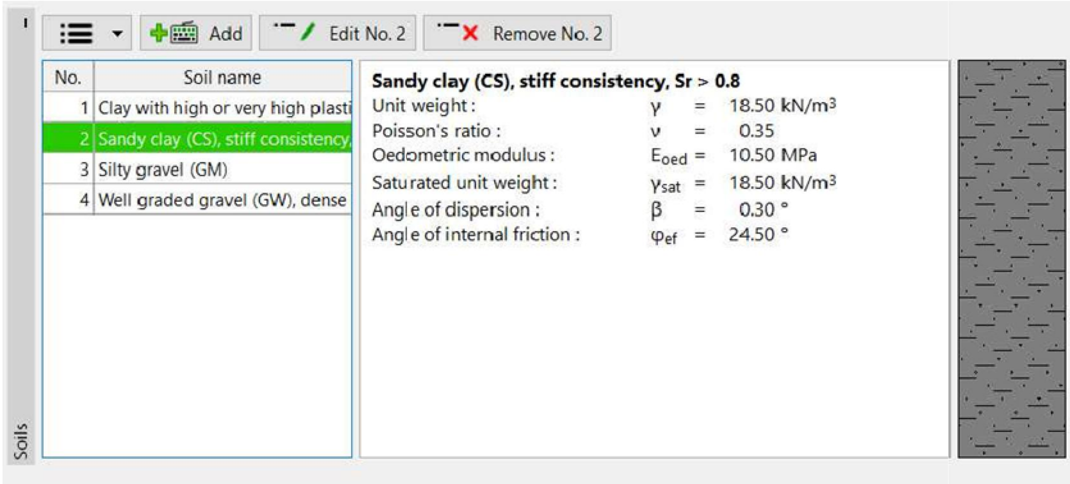

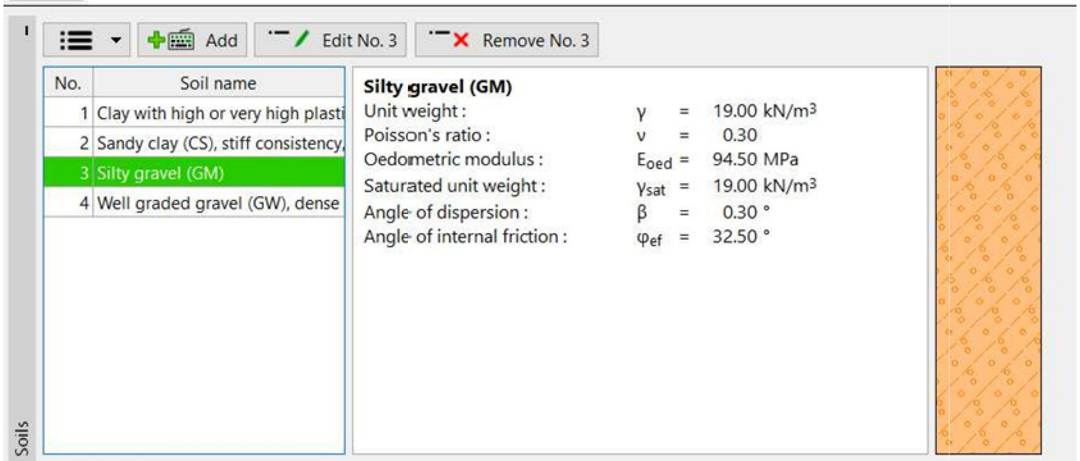

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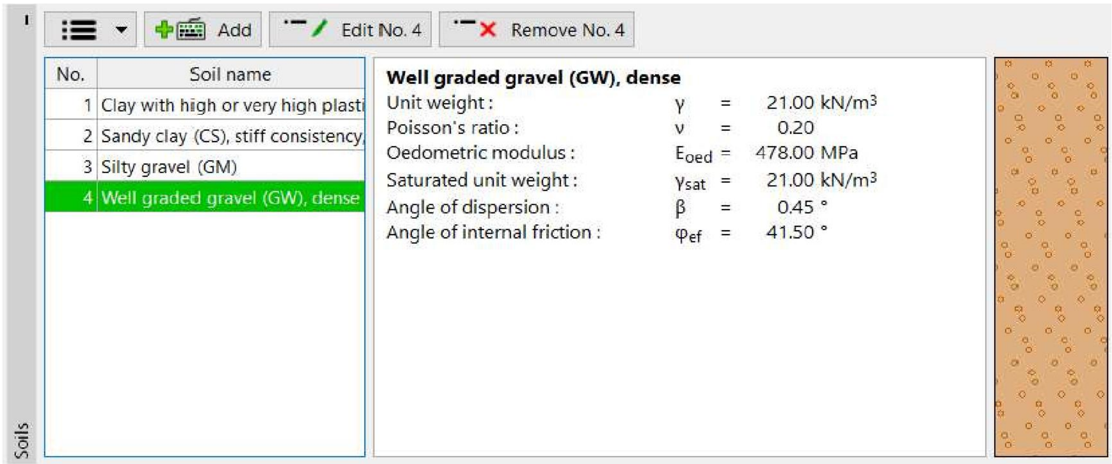

Figure 10: Soil Classification Details

Subsequently we will define the load acting on the pile. The design (calculation) loadingis considered for the calculation of the vertical load-bearing capacity of the pile,while the service load is considered for the calculation of settlement.

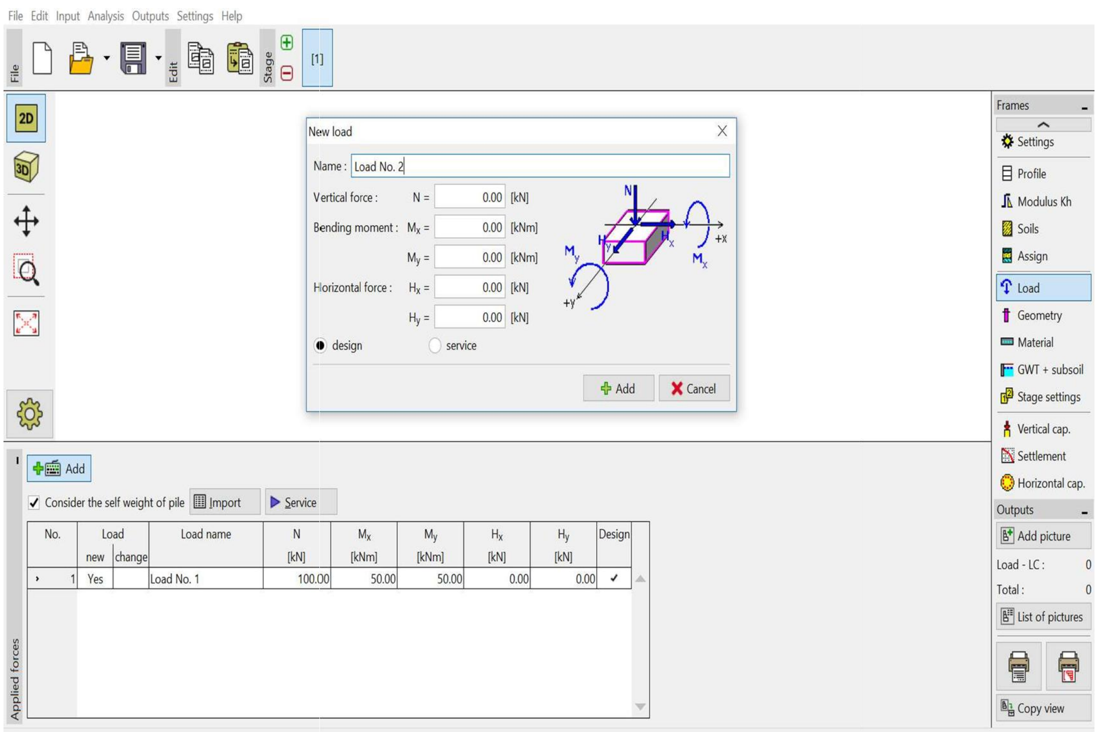

Figure 11: Loads Acting on Pile

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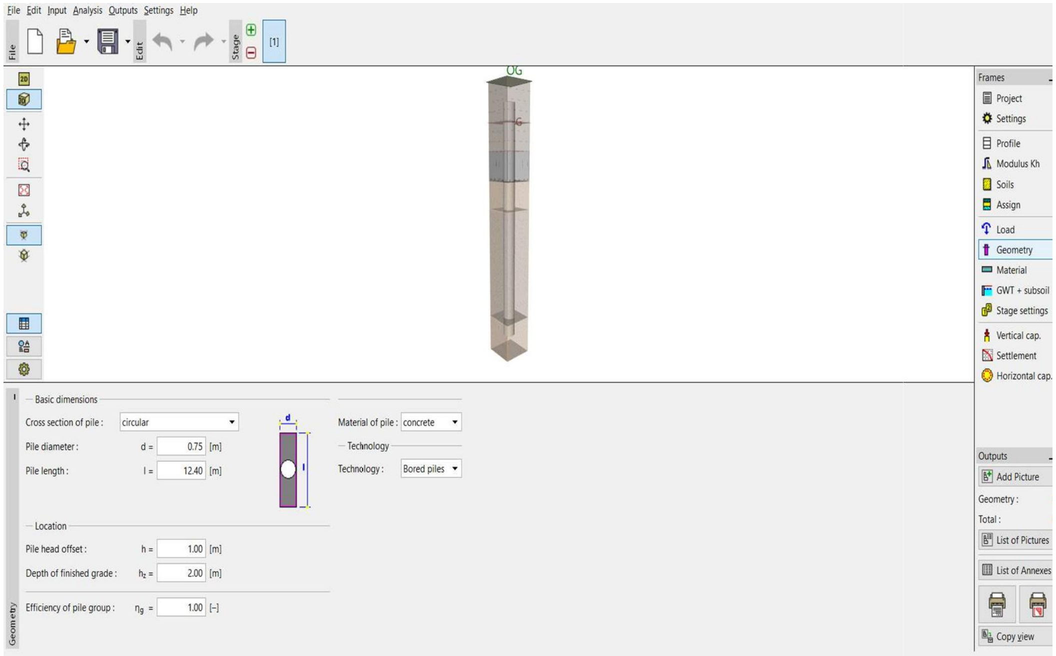

Figure 12: Pile Geometry

In the "Geometry" frame we will specify the circular cross-section of the pileand further determine its basic dimensions, i.e. the diameter and length. Subsequently we willdefine the type of the pile installation technology.

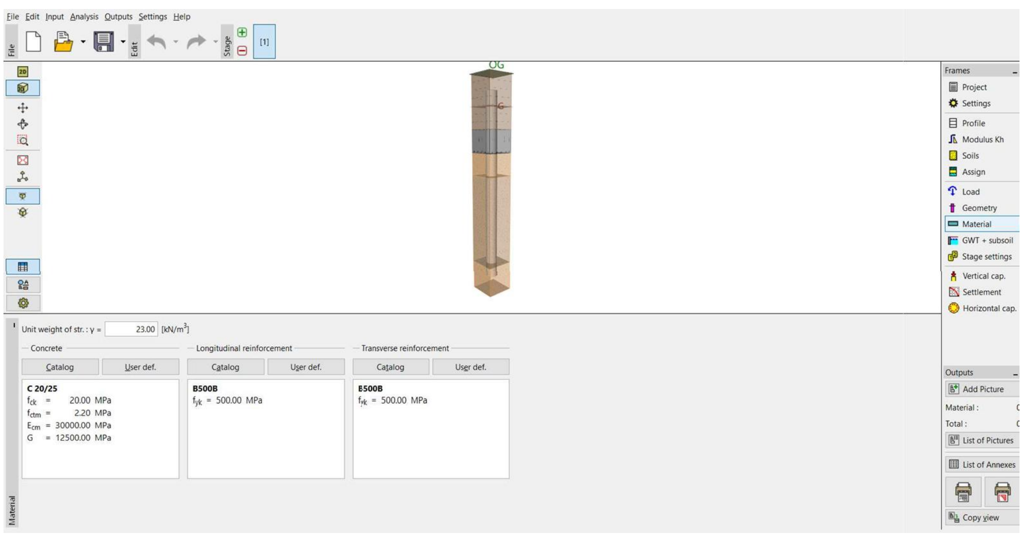

Figure 13: Pile Material

In the "Material" frame, we will specify material characteristics of the pile – unitweightof the structure 20.0Kn/m[3].

Analysis of vertical load-bearing capacity of a single pile – NAVFAC DM 7.2 analysisMethod

First we must specify in the frame "Vertical capacity" the calculation parameters affecting the magnitude of the pile base bearing capacity Rb [kN] . Another important parameter is the coefficient of bearing capacity Nq ,which is determined according to the size of the soil internal friction angle $Ø_{ef}$ [◦] relativeto the pile installation technology . Inthis case we willconsider Nq= 10.0 q N . The design vertical bearing capacity of a centrally loaded pile Rc [kN] consistsof the sum of the skin friction R_s and the resistance on pile base R_b. To meet the condition for reliability, its value must be higher than the magnitude of the design load V_d [kN] acting on the pile head. NAVFAC DM 7.2: Rc= 1627.69 kN> Vd = 263 46kN … SATISFACTORY

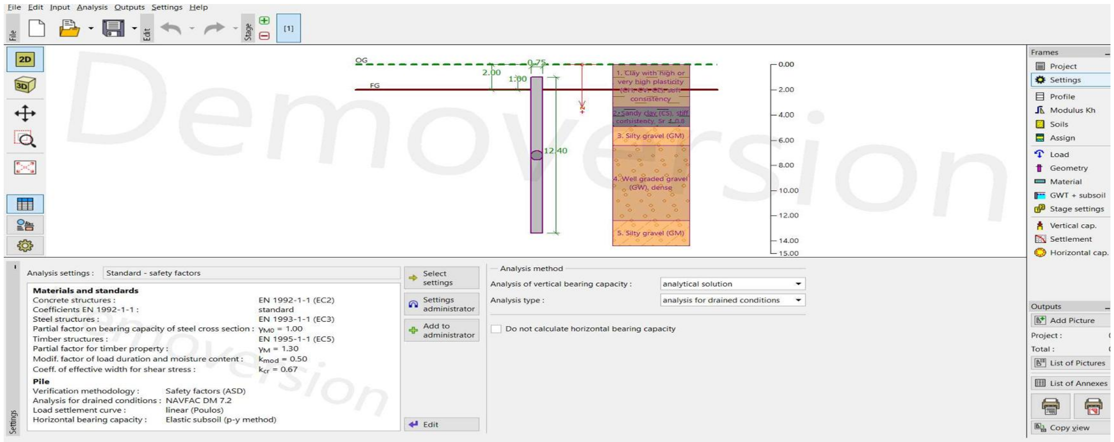

Figure 14: "Safety Factor" frame – assessment according to NAVFAC DM 7.2"

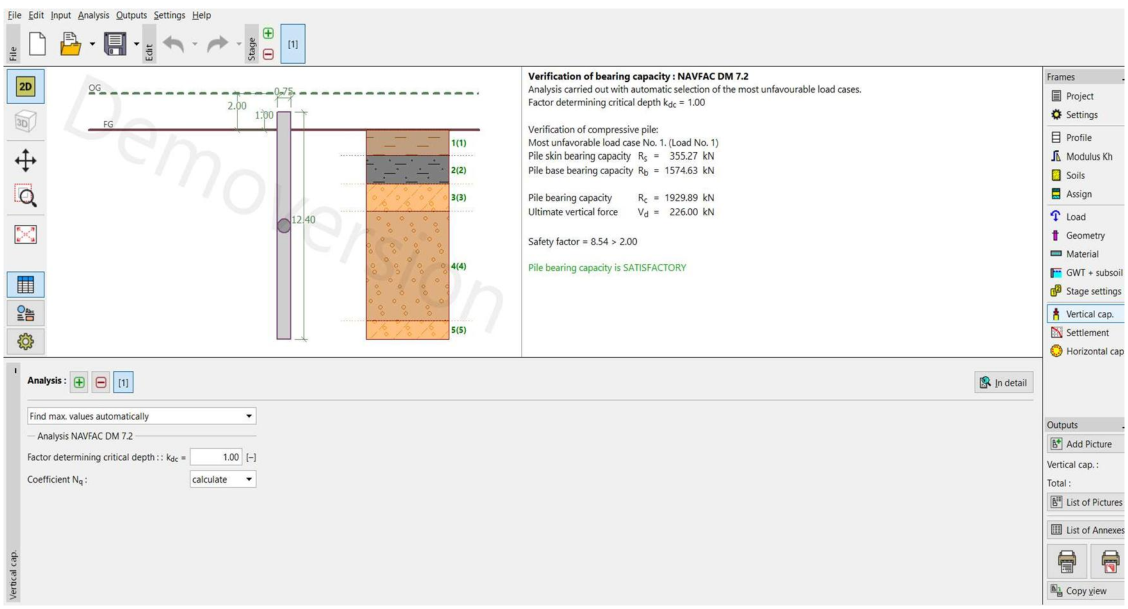

Figure 15: Vertical capacity" frame – assessment according to NAVFAC DM 7.2"

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