RE-DESIGN OF FOUNDATION OF EDUTORIUM UMS BY MANUAL CALCULATIONS AND CALCULATIONS USING GEO5 SOFTWARE

Compiled as one of the requirements of completing the undergraduate program at the department of civil Engineering Faculty

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D10A153008

CIVIL ENGINEERING PROGRAM

FACULTY OF ENGINEERING

UNIVERSITAS MUHAMMADIYAH SURAKARTA

2019

APPROVAL PAGE

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SCIENTIFIC PUBLICATION

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Has been tested in front of Examiners Faculty of Engineering
Muhammadiyah University of Surakarta
On Dec 6th 2019

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Abstrak

Desain dimensi tiang pancang optimal untuk mendapatkan stabilitas tiang terhadap geseran dan kegagalan apapun. Hal ini dilakukan melalui beberapa perhitungan manual dan penggunaan Geo5 dan membandingkan hasil dari perhitungan manual dengan hasil Geo5 untuk mendapatkan desain tiang yang sesuai. Hasil perhitungan manual dan program Geo5 berbeda ketika membandingkan kedua kapasitas dukung. Untuk perhitungan manual kapasitas dukung tiang tunggal untuk kohesi lebih sedikit dari tanah dan kohesi adalah 1182.88 KN, maka dari daya dukung untuk semua tanah dapat diperoleh faktor keamanan dari tiang tunggal dalam perhitungan manual yaitu SF = 1.3, Dan untuk perhitungan manual kapasitas dukung kelompok tiang untuk tanah kohesi, dapatkan 8836.48 KN dan kapasitas daya dukung kelompok kohesi tiang lebih sedikit, yaitu 7689.9 KN, ketika menggabungkan daya kapasitas dari kelompok tiang antara kohesi lebih sedikit tanah dan tanah kohesi, mendapatkan faktor keamanan yang aman untuk semua tanah yaitu SF = 3.06 ≥ 2 (OK). Dan dalam perangkat lunak geo5 tiang tunggal faktor keamanan untuk semua tanah itu adalah SF = 1.36, juga dalam perangkat lunak geo5 kelompok tiang faktor keamanan itu SF = 2.165 yang juga aman (ok). Dalam penelitian ini menggunakan tiga aplikasi Geo5 2019, AutoCAD 2010 dan Microsoft Office 2010.

Kata kunci: pondasi tiang pancang, pondasi tiang pancang gabungan, dan pondasi tiang pancang tunggal.

Abstract

Design optimum pile dimension to attain stability of the piles against sliding and any failure This is done through several manual calculations and the use of Geo5 and Comparing the results from manual calculations with Geo5 results to attain suitable design of piles. the results of manual calculation and of Geo5 program are different when compare both of the bearing capacities. For the manual calculation the bearing capacity of single pile for cohesion less soil and cohesion soil it is 1182.88 KN, then from the bearing capacity for all the soil can get the safe of safety factor of single pile in manual calculation it was SF =1.3, And for the manual calculation the bearing capacity of pile group for cohesion soil, get 8836.48 KN and the bearing capacity of pile group cohesion less soil, get 7689.9 KN, when combine the bearing capacity of pile group between cohesion less soil and cohesion soil, can get the safe of safety factor for all the soil it was SF =3.06 ≥ 2 (OK). And in geo5 software of single pile the safety factor for all the soil it was SF =1.36, also in geo5 software of pile group the safety factor it was SF =2.165 which is also safe (ok).in this research use three application Geo5 2019, AutoCAD 2010 and Microsoft Office 2010.

Keyword: driven pile foundation, driven pile group foundation and driven single pile foundation.

1. INTRODUCTION

The project has been chosen to make the final project is under construction in Edutoerium UMS, located in solo city – central java. Edutorium is a meeting hall from four floors with a capacity of 7,000 people and a budget of Rp266 billion. Pile foundations consist of a number of piles connected by a ring of concrete called a pile cap This is similar to a strip foundation but not as wide. One method of construction is to drive precast piles into the soil using specialized jacking systems like hydraulic jack cap. The other method requires the drilling of a driven pile in the soil, which is then poured with concrete and reinforced with steel. The only purpose of the Pile Foundation is to distribute the loads of the building to the ground , as the upper layer of the soil is considered poor and weak to take the weight of the building . The piles to be used at the construction site depend on the nature of the soil. The stability of the buildings is created by taking the pile to the strongest part of the soil. The friction pile gives strength due to friction that is created in the deeper layers of the soil. When the pile is inserted into the deeper part of the soil, the soil compacts and offers greater resistance and strength to the pile. The more the pile is inserted into the soil, greater the strength piles gives to the structure on the piles.

2. METHOD

At this research (design pile foundation by using Geo 5) to determine the dimension of the pile foundation that data taken from the Edutorium Muhammadiyah UMS, will be analyzed the soil's condition and to design of a pile foundation using the program Geo 5.The research is needed the data of soil in the Edutorium Muhammadiyah UMS such as soil. density (γ), specific gravity(Gs), Cu, and the friction angle (Φ). The data can be shown. The soil density = 16KN/$m^{3,}$ Cu= Convert Cu from qc, Friction angle (Φ)= 0° and P load=900 KN. the location of the Edutoerium UMS project can be seen in Fig.1. The flowchart of the research can be seen in Fig.1.

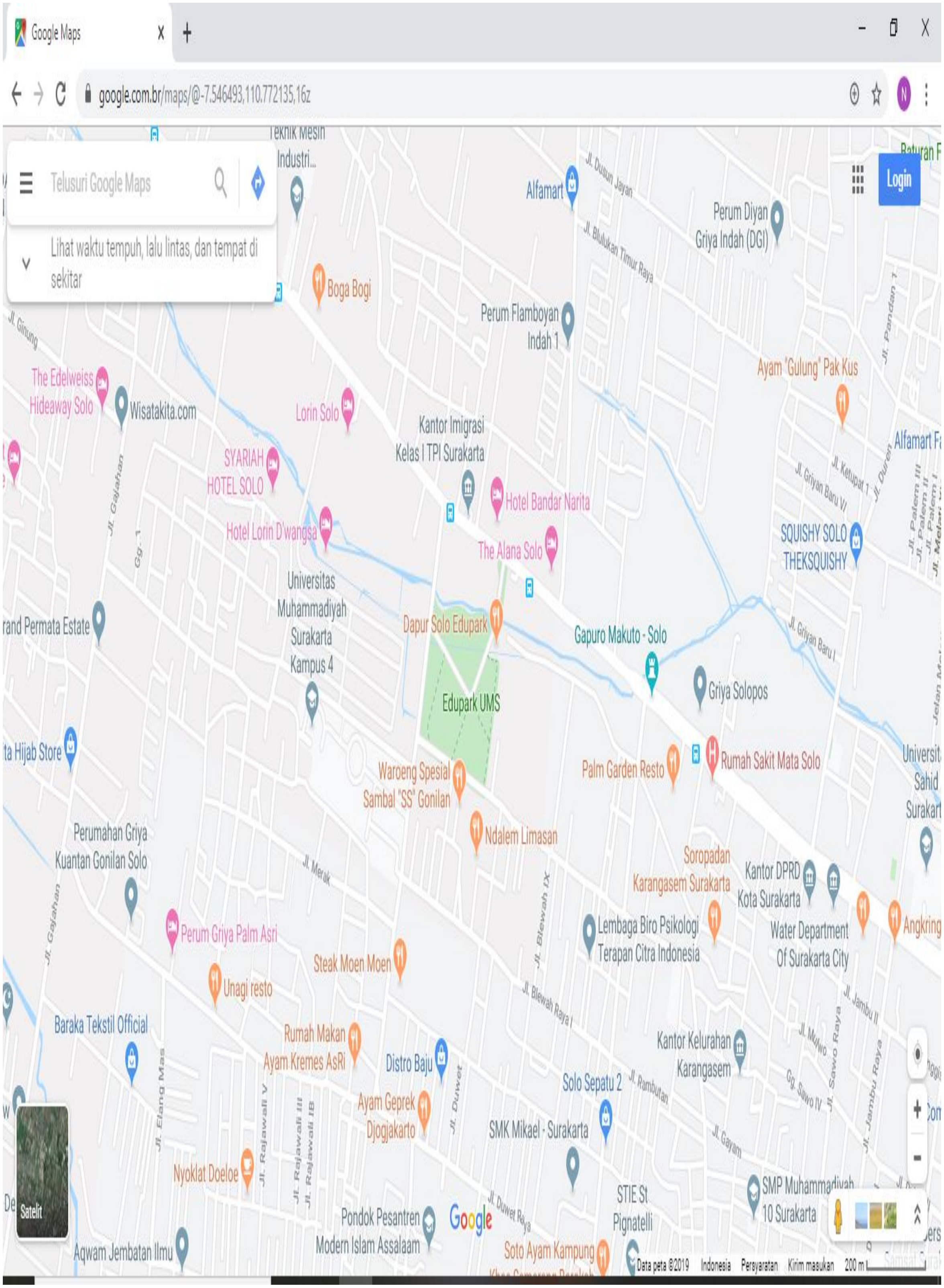

Figure 1. Edutorium UMS Location

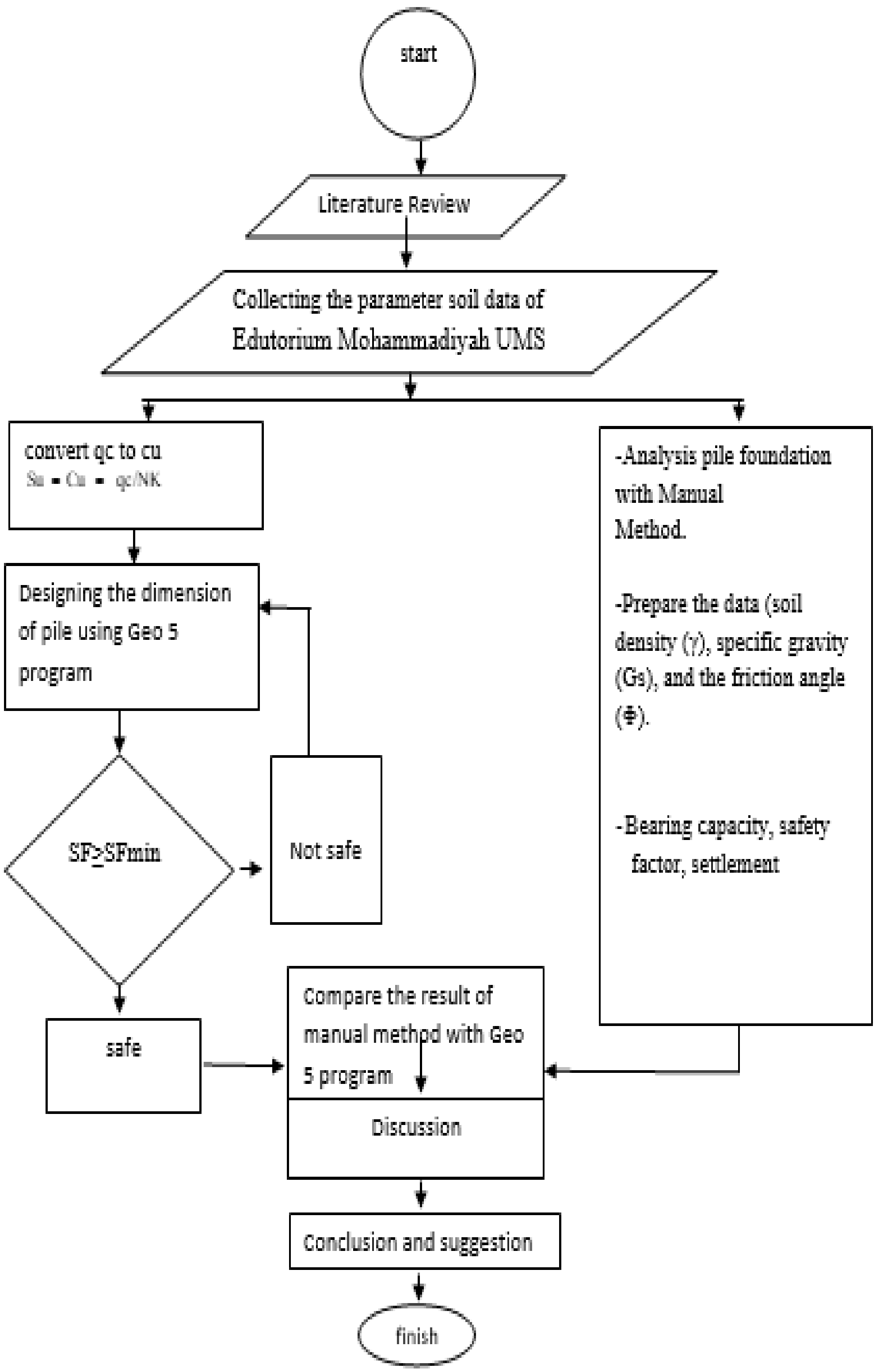

Figure 2. flowchart

3. RESULTS AND DISCUSSION

3.1. Project Data

The field test is carried out on 3 (three) filed points to the depth of the hard ground with a qc tip value of 250 kg / cm2. Data and results are test is briefly presented in the Figure3. presented in Appendix C. The graph of the results of the field test.

Table 1. Summary of the results of field testing.

Little field	Hard ground depth
S1	5,20 m
S2	5,60 m
S3	6,00 m

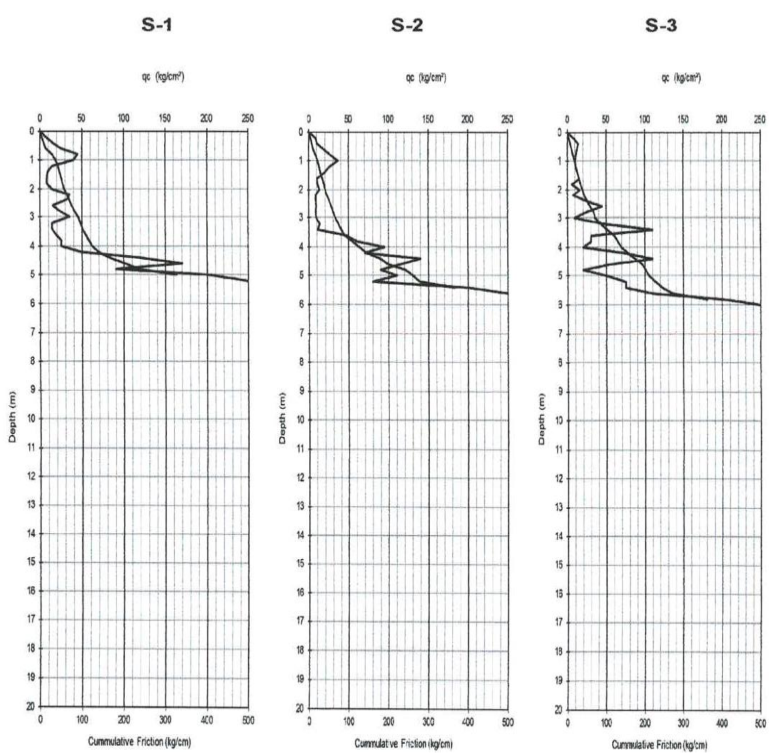

Figure3. field testing

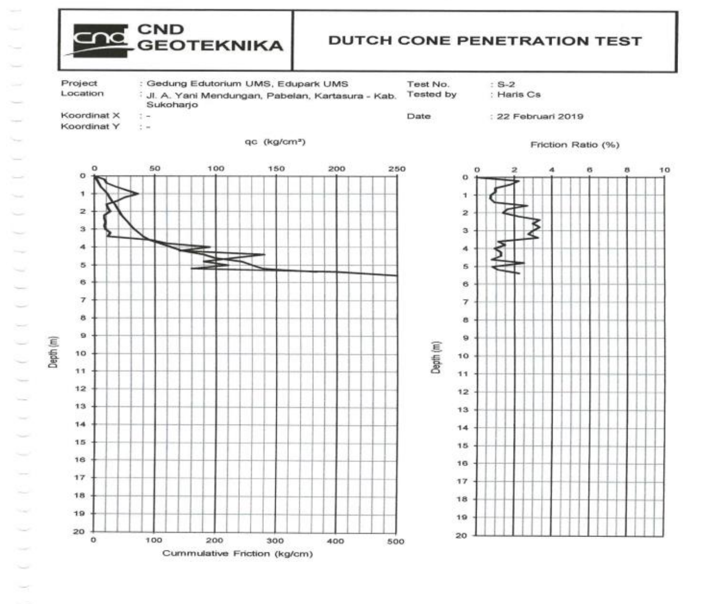

Figure.4. friction in S2

DUTCH CONE PENETRATION TEST

Project : Gedung Edutorium UMS, Edupark UMS
Location : Jl. A. Yani Mendungan, Pabelan, Kartasura - Kab. Sukoharjo
Koordinat X : -
Koordinat Y : -

Test No. : S-2
Tested by : Haris Cs
Date : 22 Februari 2019

Depth (m)	qc (kg/cm²)	Wt (kg/cm²)	fs (kg/cm²)	fs/qc %	Tf (kg/cm)	Cummul. Tf (kg/cm)
0.00	0	0	0.00	0.00	0.00	0.00
0.20	8	10	0.18	2.23	3.56	3.56
0.40	10	12	0.18	1.78	3.56	7.12
0.60	18	20	0.18	0.99	3.56	10.68
0.80	27	30	0.27	0.99	5.34	16.02
1.00	36	39	0.27	0.74	5.34	21.36
1.20	25	27	0.18	0.71	3.56	24.92
1.40	19	21	0.18	0.94	3.56	28.48
1.60	10	13	0.27	2.67	5.34	33.82
1.80	11	13	0.18	1.62	3.56	37.38
2.00	13	15	0.18	1.37	3.56	40.94
2.20	8	10	0.18	2.23	3.56	44.50
2.40	8	11	0.27	3.34	5.34	49.84
2.60	9	12	0.27	2.97	5.34	55.18
2.80	8	11	0.27	3.34	5.34	60.52
3.00	9	12	0.27	2.97	5.34	65.86
3.20	13	17	0.36	2.74	7.12	72.98
3.40	11	15	0.36	3.24	7.12	80.10
3.60	47	53	0.53	1.14	10.68	90.78
3.80	60	70	0.89	1.48	17.80	108.58
4.00	95	105	0.89	0.94	17.80	126.38
4.20	70	80	0.89	1.27	17.80	144.18
4.40	140	160	1.78	1.27	35.60	179.78
4.60	115	125	0.89	0.77	17.80	197.58
4.80	90	115	2.23	2.47	44.50	242.08
5.00	110	120	0.89	0.81	17.80	259.88
5.20	80	90	0.89	1.11	17.80	277.68
5.40	200	250	4.45	2.23	89.00	366.68
5.60	250					
5.80						
6.00						
6.20						
6.40						
6.60						
6.80						
7.00						
7.20						
7.40						
7.60						
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8.00						
8.20						
8.40						
8.60						
8.80						

Figure.5. Data of S2

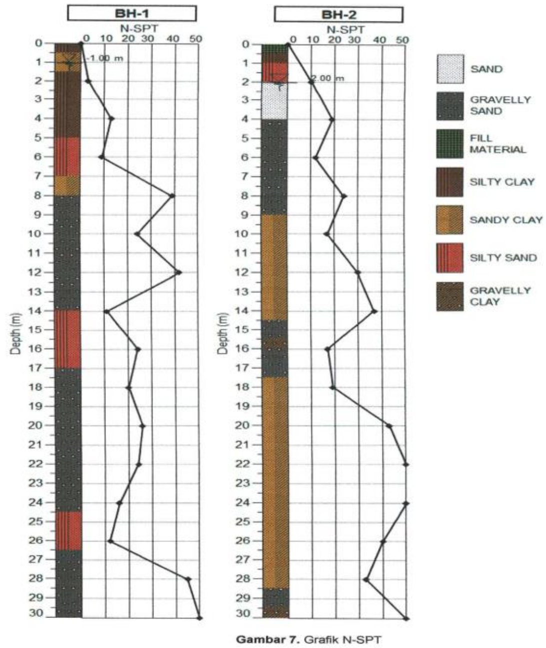

Figure.6. soil investigation

Location	Sample no.	Depth	Water Content (w_n)	Unit Weight (γ_n)	Specific Gravity (G_s)	Grain Size Analysis				Atterberg Limit				Consolidation				Triaxial UU		Direct Shear	
						Clay	Silt	Sand	Gravel	W_L	W_P	I_P	Classification	Pc	e_o	Cv	Cc	ϕ	C	ϕ	C
		(m)	(%)	(t/m^3)		(%)	(%)	(%)	(%)	(%)	(%)	(%)		kN/m^2	-	cm^2/sec	-	(°)	(kN/m^2)	(°)	(kN/m^2)
Jl. A. Yani Mendungan, Pabelan, Kartasura - Kab. Sukoharjo	BH-1	3.50-4.00	33,62	1,71	2,50	21	35	43	1	-	-	-	-	145,00	0,9848	1,14E-02	0,1457	12,9	20,0	-	-
		7.50-8.00	34,80	1,81	2,64	19	55	25	1	36	26	11	ML	156,00	1,0000	1,23E-02	0,1661	13,1	46,8	-	-
	BH-2	1.50-2.00	22,50	2,01	2,72	23	19	58	0	-	-	-	-	113,50	0,6148	4,89E+00	0,0791	36,1	48,8	-	-
		9.50-10.00	49,29	1,67	2,70	30	52	18	0	50	33	17	ML	105,50	1,3875	5,49E+00	0,3443	-	-	23,54	17,566

Figure.7. data soil investigation

3.2. SINGLE PILE

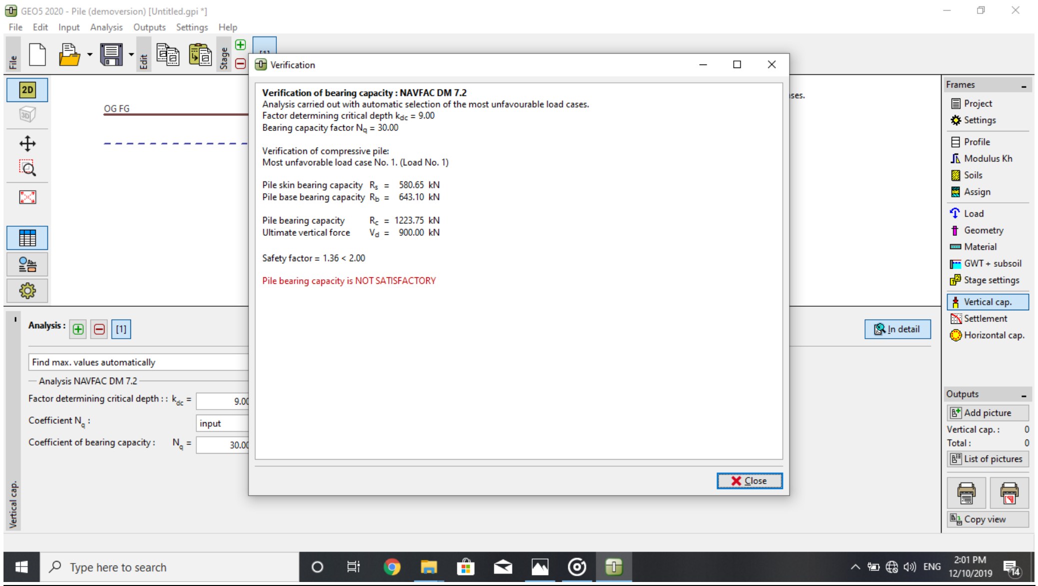

Figure.8. Bering capacity result of single pile

3.3. PILE GROUP

a. cohesion soil

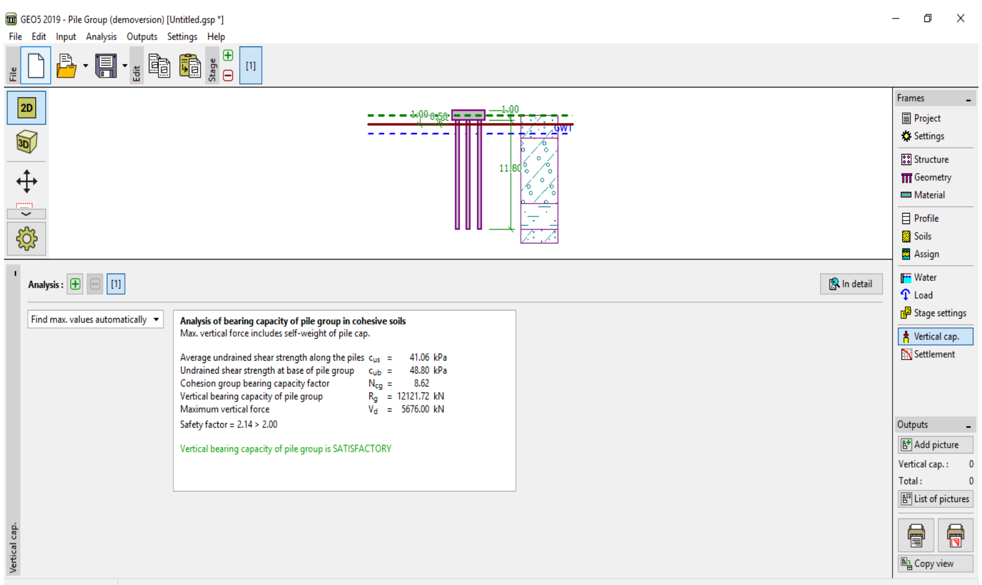

Figure.9. Bearing capacity result of cohesion soil

b. cohesion less soil

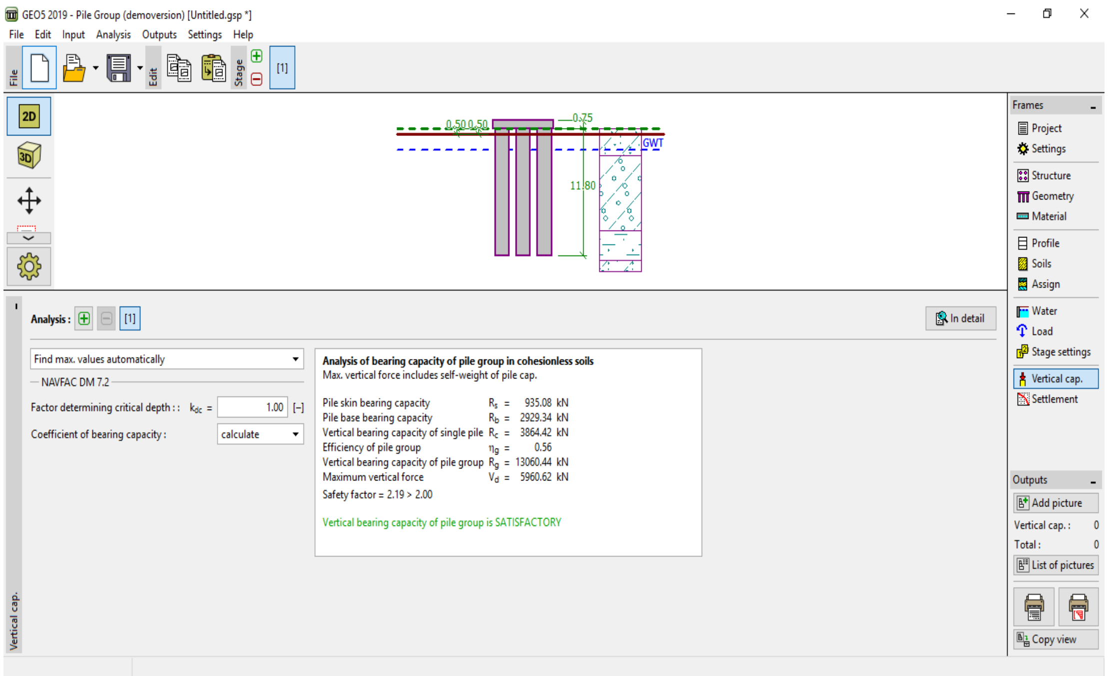

Figure .10. Bearing capacity result of cohesion less soil

3.4. DISCUSSION

After making some changes in the procedures of making manual calculations, it is found out that get a much closer safety factor of single pile in manual calculations to that of Geo5 software. The changes made were in combining both cohesion and cohesionless soils into one calculation procedure. This was done by calculating shaft friction of cohesionless soil first, from 0m to 9m using cohesionless formula. Then calculated shaft friction of cohesion soil from 9m to 11.8m using the appropriate formula.it is proceeded that way to get the end bearing and then combined the results and subtracted the weight of the pile to get the ultimate bearing capacity which was 1182.88 KN. The safety factor was gotten by dividing the ultimate bearing capacity with the applied load on pile which was 900 KN. The safety factor gotten was 1.3 which is less than safety factor minimum.

The above results gotten from manual calculations are slightly closer to those gotten from Geo5 software. For the Geo5 software, got pile bearing capacity Rc =1223.75 KN from the same applied load. The safety factor gotten was 1.36 which is closer to the S.F =1.3 from manual calculations. The following table shows results comparison from both manual and Geo5 software.

Table.2. Result of manual calculation and Geo 5 program of single pile:

	Manual calculation of single pile	Software geo5
Shaft friction	677.63 KN	580.65 KN
End bearing	562.6 KN	643.10 KN
Ultimate bearing capacity	1182.88 KN	1223.75 KN
S.F	1.3	1.36

From the analysis made due to the results it got, and after noticed a slight difference in the results between manual calculations and Geo5 software, the following are some of the variations that brought about that difference in the results:

❖ The software considers a lot of variables like:

- Poisson’s ratio
- Coefficient of lateral stress
- Elastic modulus is also included since we used Vesic subsoil modulus.
- Material

When look at the above variables in both manual software calculations, it can be certain that we CAN NOT get exactly the same values from both calculation procedures. The above is the reason as to why this final project was about comparing the results from the two procedures since they are some slight differences in the variables.

And for the manual calculation when calculated the bearing capacity of pile group for cohesion soil, get 8836.48 KN. and when calculated the bearing capacity of pile group cohesion less soil, get 7689.9 KN. after that combine the bearing capacity of pile group between cohesion les soil and cohesion soil, it can get the safe of safety factor it was SF =3.06 ≥ 2 (OK). which is greater than the minimum required safety.

And for the Geo5 calculation when calculated the bearing capacity of pile group for cohesion soil, and cohesion less soil. Then get the safety factor after combine the bearing capacity between cohesion and cohesion less soil it was 2.165≥ 2 (OK).

Table.3. Result of manual calculation and Geo 5 program of pile group:

filer model	Resisting component	Symbol	Minimum of safety factor	Safety Factor		Remark
				Manual Pile group	Geo5 Pile group	
Safety factor	Resisting Load	FSL	2.00	3.06	2.165	Safe

After observing the data result on Table 3. It is can conclude that the final result of manual calculation using manual method gives us a slightly different safety factor than geo5 software. This means that there are a lot of variables in the manual calculations than geo5 software. The geo5 program gave us a relatively smaller safety factor than from manual calculations which was basically not safe. While using the geo5 software, it is easier to adjust to the optimum dimensions of the pile in order to get the desired safety factor.

4. CONCLUSIONS

The main purpose of this final project is to compare the safety factors from both the manual calculations and geo5 software. And as we saw from the analysis of the data from both calculations, we can conclude that;

1. It is safer to use both manual and software results because there a lot of variables that might be covered in the software but manual calculations would cover them.
2. The dimensions of the safer piles can be easily adjusted while using geo5 software making it less time consuming as time being the most valuable asset in any project.

3. The geo 5 software gives a smaller safety factor than manual calculations. As we can see from table 3, manual calculations gave us a safety factor of 1.3 on single piles and a safety factor of 3.06 on group piles. Whereas the software gave us a safety factor of 1.36 on single piles and a safety factor of 2.165 on group piles.

4.1. Suggestion

The author suggests that the following precautions must be taken before and while doing manual and geo5 calculations for the best results:

1. The soil data must be accurate and the types of soils gotten from soil investigation must be clear so as to know which type of piles to be used.
2. For cohesive less soils, the friction angle of soil (φ) is important and can change the results gotten. Therefore, care must be taken while getting this angle.
3. While using geo5 software, in the geometry part, the pile head offset value is so important in getting the desirable safety factor. The value must be adjusted to get the optimum value for the safer safety factor.

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