IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 2 Ser. I (Mar. - Apr. 2019), PP 54-57
www.iosrjournals.org

The Study of Enhancement of Load Carrying Capacity of Micropile in Soil Stabilization for Different Regions in India.

Suhail Ahmad[1], Nazimali Chinwala[2]
[1]*(Department of Civil Engineering, Parul Institute of Technology, India)*
[2]*([2]Faculty of Engineering & Technology, Parul Institute of Technology, India)*
Corresponding Author: Suhail Ahmad

Abstract: *In this Study, we must stabilize the soil mass by using micropile. The micropile which is provided for soil stabilization is not greater than 300 mm in diameter. This type of study is taken because there are some limitations for execution of Soil Stabilization by a different technique like by providing pile having diameter is greater than 300 mm. If we provide pile then the heavy machinery is not easily going to site & create more vibration which affects the old building is existing nearby but in case of micropile the headroom required is less, the machine is lighter than pile M/c and creates very less vibration as compared to a pile. Also, the axial and lateral force a consideration during the design of micropile but in case of pile designing only axial force get into consideration. Micropile can be inclined or vertical but in case of the pile, it should be vertical. The main objective of this study is to evaluate the feasibility of micropile based on geotechnical site data also minimize the diameter and maximize the load capacity of different soils of the various location of India. Collection the bore log data of a different region in India & analyses on Software for different C and ϕ value of Soil. By getting these results we are going to find out some relationship between load, diameter, and type of soil. There the various application of this study in different sectors like supporting maximum load and excavation supports in congested areas, seismic structure foundation.*

Keywords: *Micropile, Slope Stabilization, angle of Internal friction, Cohesion.*

Date of Submission: 26-02-2019 Date of acceptance: 12-03-2019

I. Introduction

A micropile is a small diameter (less than 300 mm) drilled and grouted pile that is typically (up to 20% As/Ac) reinforced. This type of pile would be considered a non-displacement pile. Micropiles can be installed at any angle, where access is restrictive, and in virtually all soil types and ground conditions. Micropiles are used for slope stabilization to provide the necessary restraining forces to structurally support the slope. Battered, and possibly vertical, micropiles are installed through the unstable slope to a designed depth below the failure surface to establish a system. In doing this, the micropiles provide axial, shear, and bending resistance. Most importantly, they help resist the shear forces that develop along the failure surface

Slopes are generally two types one is manmade and other is natural, but they are going to fail due to various reasons. When slope fails various damages of life and property will come into picture. In hilly region these are very common due slope instability and mass movement of soil.

Improving the stability of slope is main aim in geotechnical engineering which depends on the factor of safety of a slope. Factor of safety is found out by the ratio of resisting force to the driving force. There are so many methods are available to evaluate slope stability as well as to improve it. One of the methods is by installation of micropile to improve the slope stability.

Micropiles are used to improve the stability of slope also its take axial as well as bending resistance. It can be installed vertical as well as at certain angle but in this study, we must optimize at which angle the micropile is best suited for different cohesions and angle of internal friction. The cross section of the installation of micropile is shown in figure 1.

II. Previous literature

Various studied are carried out on micropile which is used in different sector like transportation projects, structural projects and slope stabilization. It is used for to establish new foundation, underpinning of existing foundation, seismic retrofit, to resist lateral loading, to resist liquefaction, load sharing with existing foundation and in earth retention structure.

The reference manual for Micropile Design and Construction (FHWA SA-97-070) was published by U. S. Department of Transportation, Federal Highway Administration (FHWA) in June 2000 but in this manual the design and construction details of micropile used in slope stabilization is not given. Further studies were carried out by Sabatini *et.al* in December 2005 and updated the manual (FHWA-NHI-05-039). In FHWA detailed procedures for design of Micropile for soil stabilization are given.

Turner and Halverson (2013) proposed the upslope angle between 25° to 35° and downslope is near to vertical or between 5° to 10° also generally spacing between them are 0.8 m to 1.1 m.

III. Study Of Soil Properties And Calculations

The geotechnical properties of soil sample collected from the different site location from India are presented in Table 1.

The shear resistance provided by the single vertical micropile, H_{req}, can be modeled as relatively large cohesive shear strength assigned to the soil layer where the micropile crosses the potential slip surface.

$$H_{req} = c \times L \tag{1}$$

Where

C = Cohesive strength

L = Length of the slice

H_{req} = Required shear force

The axial force required to be resisted by the micropile below the potential slip surface is assumed to be equal to the ultimate side resistance of the micropile that could develop above the failure surface with a factor of safety. The ultimate side resistance of the micropile above the failure surface, P_{ult}, can be calculated as:

$$P_{ult} = \alpha_{bond-above} \times L_{above} \times \pi \times d \tag{2}$$

Where $\alpha_{bond-above}$ is the grout-to-ground ultimate bond strength above the critical slip surface, L_{above} is the length of the micropile from the slip surface to the bottom of the cap beam, and d is the diameter of the micropile. The value for $\alpha_{bond-above}$ is estimated using Table 2.

In addition to axial resistance, micropiles develop flexural resistance. The design objective, therefore, is to select a micropile system with enough structural capacity to resist the unbalanced slope force (i.e., H_{req}) without structural failure of the micropile in combined axial loading and bending.

Therefore, the required length of the micropile below the slip surface, L_{below}, is calculated as:

$$L_{below} = \frac{P_{ult}}{\alpha_{bond-below} \times \pi \times d} \times FS \tag{3}$$

Where P_{ult} is calculated by equation 2, $\alpha_{bond-below}$ is the grout-to-ground ultimate bond strength below the critical slip surface and is estimated using Table 2. A FS = 2.0 should be used in equation 3.

The maximum lateral force (H_{ult}) that an inclined (or battered) single micropile can resist at the location of the critical slip surface is evaluated in this step. For the analysis, the effects of a non-horizontal slip surface are also addressed. The value for H_{ult} which will be compared to the required force to provide the target factor of safety, i.e., H_{req}, is the sum of the individual H_{ult} values from each battered micropile in the cross section.

$$H = Q\ cos\psi + P\ sin\psi \tag{4}$$

$$H_{ult} = P_{ult}\ cos\psi + P_{ult}\ sin\psi \tag{5}$$

Spacing required to provide required force to stabilize the slope may be evaluated as

$$S_{max} = \frac{H_{ult}}{H_{req}} \tag{6}$$

IV. Figures And Tables

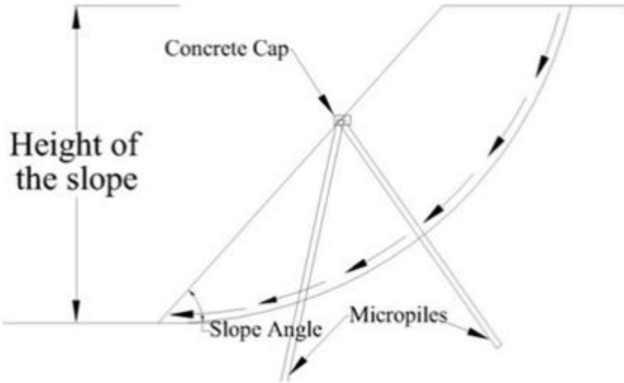

Fig. 1: Cross section of micropile

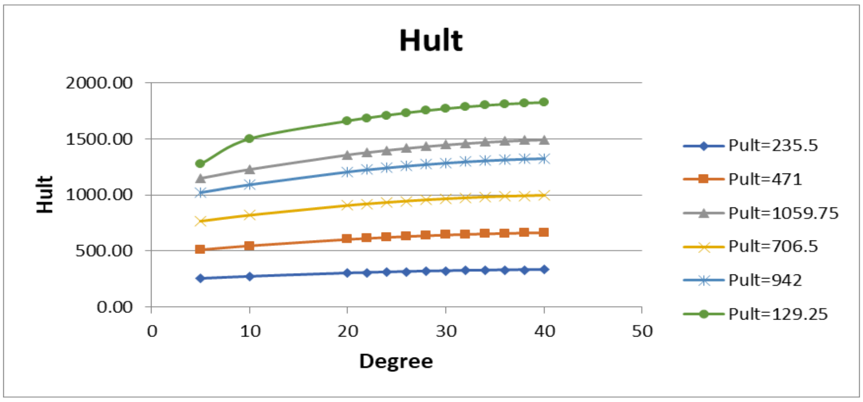

Figure 2. Bettered angle for micropile installation

Table 1. Laboratory test results on collected different soil samples

Parameters		Values					
Locations		1	2	3	4	5	6
Field Moisture Content (%)		21.48	26.63	27.19	21.93	23.59	9.33
Specific Gravity		2.67	2.83	2.80	2.59	2.80	2.66
Atterberg Limits	Liquid Limit (%)	45	64	66	49	48	40
	Plastic Limit (%)	19	29	30	20	23	20
	Shrinkage Limit (%)	26	35	36	29	25	20
Particle Size Distribution	Gravel (%)	2	14	12	9	9	1
	Sand (%)	16	32	28	25	35	18
	Silt + Clay (%)	82	54	60	66	56	81
Soil Classification		CI	CH	CH	CI	SM	CL
Shear Properties	Cohesion (kN/m^2)	74.56	125.57	141.26	82.4	75.54	68.67
	Angle of internal Friction (ϕ)	13.2	10.7	8.9	12.3	11.4	31.9

Table 2. Summary of Typical α_{bond} (Grout-to-Ground Bond) Values for Micropile Design.

Soil / Rock Description	Grout-to-Ground Bond Ultimate Strengths, kPa			
	Type A	Type B	Type C	Type D
Silt & Clay (some sand) (soft, medium plastic)	35-70	35-95	50-120	50-145
Silt & Clay (some sand) (stiff, dense to very dense)	50-120	70-190	95-190	95-190
Sand (some silt) (fine, loose-medium dense)	70-145	70-190	95-190	95- 240
Sand (some silt, gravel) (fine-coarse, med.-very dense)	95-215	120-360	145-360	145-385
Gravel (some sand) (medium-very dense)	95-265	120-360	145-360	145-385
Glacial Till (silt, sand, gravel) (medium-very dense, cemented)	95-190	95-310	120-310	120-335
Soft Shales (fresh-moderate fracturing, little to no weathering)	205-550	N/A	N/A	N/A
Slates and Hard Shales (fresh-moderate fracturing, little to no weathering)	515-1,380	N/A	N/A	N/A
Limestone (fresh-moderate fracturing, little to no weathering)	1,035-2,070	N/A	N/A	N/A
Sandstone (fresh-moderate fracturing, little to no weathering)	520-1,725	N/A	N/A	N/A
Granite and Basalt (fresh-moderate fracturing, little to no weathering)	1,380-4,200	N/A	N/A	N/A

Table 3. Summary of load at different angle (5° *to* 40°)

Degree	P_{ult}=235.5	P_{ult}=471	P_{ult}=1059.75	P_{ult}=706.5	P_{ult}=942	P_{ult}=129.25
5	255.11	510.21	1147.98	765.32	1020.43	1275.53
10	272.80	545.61	1227.61	818.41	1091.21	1500.42
20	301.84	603.69	1358.30	905.53	1207.37	1660.14
22	306.57	613.14	1379.57	919.71	1226.29	1686.14
24	310.93	621.85	1399.17	932.78	1243.71	1710.10
26	314.90	629.80	1417.06	944.71	1259.61	1731.96
28	318.49	636.99	1433.23	955.48	1273.98	1751.72
30	321.69	643.39	1447.62	965.08	1286.77	1769.31
32	324.51	649.02	1460.30	973.53	1298.05	1784.81
34	326.93	653.86	1471.18	980.78	1307.71	1798.11
36	328.95	657.89	1480.26	986.84	1315.79	1809.21
38	330.56	661.13	1487.54	991.69	1322.26	1818.11
40	331.78	663.56	1493.01	995.34	1327.12	1824.79

V. Conclusion

In comparing the bettered angle of inclination of different cohesion and angle of friction of constant diameter and constant length by using all above equations we get the optimum angle of inclination is 30° where the value of H_{ult} is maximum and after that angle further increase in angle but very slightly changes in the value of H_{ult}, there for 30° angle is better for practically insert the micropile for above Cohesions and angle of internal friction to stabilize the slope. It's also given below in the fig. 2 as well as in table 3.

References

[1]. Howe, W. K. (2010). Micropiles for Slope Stabilization. GeoTrends.

[2]. K, A., & K, N. (2017). Design of Micropile Slope Stabilization System in Kakkayam. Indian Geotechnical Conference.

[3]. Sabatini, P. J., Tanyu, B., Armour, T., Groneck, P., & Keeley, J. (n.d.). Micropile Design and Construction. Federal Highway Administration.

[4]. Turner, J. P., & Halvorson, M. (2013). Design Method for Slide-Stabiliing Micropile Walls. Geo-Congress.

Suhail Ahmad. "The Study of Enhancement of Load Carrying Capacity of Micropile in Soil Stabilization for Different Regions in India." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 16, no. 2, 2019, pp. 54-57