The Study Deformation Of Bore Pile Foundation Caused by Horizontal Load In Soft Clay

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Abstract

A sturdy of building must be contain with a strong foundation, which is able to withstand the burden on it; channel the load into the ground and be able to withstand external forces such as earthquakes. In this study discussed the deformation of the bore pile foundation due to horizontal load on the soil slope by using the Lpile application.The aim is to know the displacement of foundation motion due to horizontal loads using the Lpile application, Lateral bearing capacity analysis which is important aspect in the design of the foundation to anticipate the failure of the pile foundation. One method is the p-y curve, It is a development of the Beam method in the Winkler Foundation.

Keywords: *Bore pile, application Lpile, horizontal load, p-y curve*

1. Introduction

Civil structures consist of upper and lower structures [1]. The upper structure consists of construction of columns, beams, plates, etc. Whereas the lower structure consists of foundation in construction. The foundation is the structure of the underside of a building that is directly related to the ground, or a part of the building which is located below the surface of the land which has the function of bearing the burden of other parts of the building above it [2].

One of the foundations that can be used for multi-storey buildings such as malls is the bored pile foundation. Bore Pile foundation is a form of Deep Foundation that is built in the soil with a certain depth.The installation is done by drilling the ground first [3].

The p-y curve method models the soil as a non-linear spring [4]. This method was introduced by McClelland and Focht in 1956 in the form of a curve of the relationship of the soil reaction with deflection due to lateral loads, the p-y curve method is more commonly used because the process is not complicated when compared with other methods and the results are reliable [5]. However, the p-y curve method does not take into account the effect of the cross section because the pile is simplified into a one-dimensional pile model with an empirical approach [6].

2. Literature Review

2.1 Foundation

The foundation is a part of the building that is directly related to the land, and functions as a channeling of building loads to the ground [7]. The foundation usually extends underground. Broadly speaking, the foundation is only divided into 2 types which are shallow foundations and deep foundations. These shallow foundations are used if the burden carried on the soil is not too large whereas deep foundations can be used to transfer loads to deeper soil layers until a soil type that is able to support load on building structures [8].

2.2 Lateral carrying capacity

The permissible lateral load can be obtained based on 2 criteria, namely by dividing the ultimate load with a safety factor and based on the maximum allowable deflection. Reese Matlock theory determines ultimate lateral capacity based on lateral deflection clearance, this method uses a subgrade reaction approach. In this method, poles are distinguished by rigid poles (short poles) and elastic poles (long poles) and the condition of the pile heads being squeezed and free.

2.3 P-y curve method

The p-y curve method is one of the settlement methods for analyzing lateral deflection of the pile [9]. This method defines the relationship of lateral loads and deflection between the soil and piles depicted in the p-y curve [10]. The p-axis is the lateral resistance of the pile's long union land and the y-axis is the lateral deflection of the pile.

Below are the parameters used to mean applied:
1. c_u (Undrained Shear Strength)
    The value of cu can be calculated by using the formula cu = 0.6 N (t / m2) or cu = 6 N (kPa).
2. Shear angle (ϕ)
    Deep shear angle is an angle formed from the relationship between normal stress and shear stress in soil or rock material. Deep shear angle is the fracture angle formed if a material is subjected to a stress or force over it that exceeds the shear stress. The greater the shear angle in a material, the material will be more resistant to accept the outside stress imposed on it. The correlation between NSPT and shear angle according to some experts as follows can be seen in the Figure below:
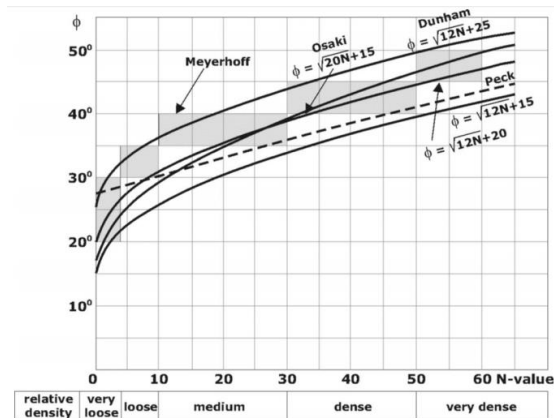

Fig 1. NSPT Correlation and Shear Angle

3. The parameter ε50

    In the ε50 data it has to be seen in the cu data that has been calculated from the beginning, because the cu data becomes a reference to the ε50 data can be seen in the Table below:

Table 1. Parameters ε50

Type of soil	c_u (kPa)	ε_{50}
Very soft	>12	0,02
Soft	12-24	0,02
Medium	24-48	0,01
Stiff	48-96	0,006
Very stiff	96-192	0,005
Hard	<192	0,004

3. Methods

3.1 Technical data collection

Using primary data and secondary data, literature and references.

3.2 Calculation of foundation

The type of pole used is the Bore Pile, the shape of the foundation is round (D = 0.4 m,

A = 0.125664 m2, circumference = 1.256637 m) and the foundation depth = 16 m.

3.3 Soil data

soil data used as follows:

Tabel 2. Soil data

Depth (m)	ΔH (m)	Type of soil	N_{SPT}
1	1	Silty	2
3	2	Clay	1
7	4	Clay	2

12.5	5.5	Clay	3
16	3.5	Sand	20
20	4	Silty	25
22.5	2.5	Silty	26
25	2.5	Sand	35
27	2	Sand	35
29	2	Sand	35

3.4 Plan load

The lateral load entered at 23 Kn and 24 kn will make a comparison between these two

4. Results and Discussion

From the above data it will be entered into the Lpile application can be seen in the following section:

4.1 Calculation results of parameters

Table 3. Result of parameter calculation

Layer Thickness (m)	Type of soil	N-SPT	γ
12.5	Solf clay	3	6.8
18	Sand	20	7
25	Sand	35	7

Next is to enter all the data needed in the Lpile application can be seen in the next way.

1. Enter foundation data

Foundation data includes pile type, pile dimensions, concrete options and pile reinforcement.
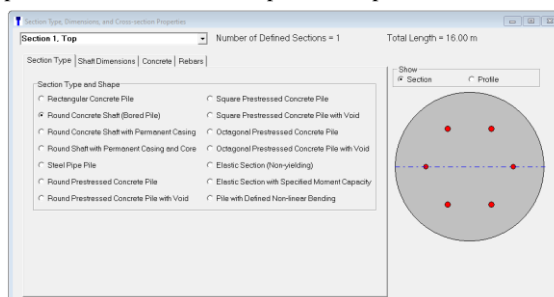
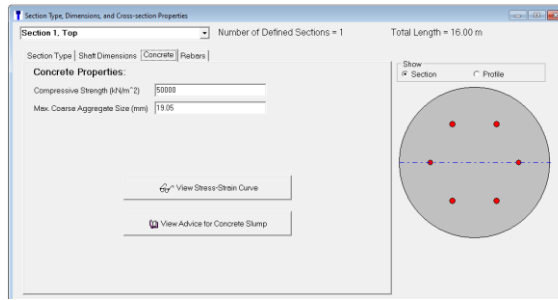**Fig 2**. Pile Type
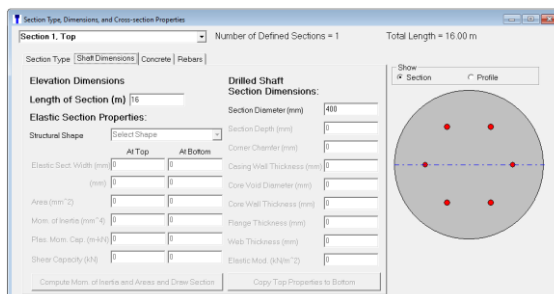
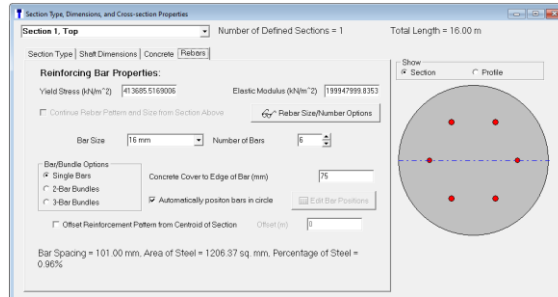**Fig 3.** Pile Dimensions

Fig 4. Concrete option

Fig 5 . Pile Reinforcement

2. Insert the lateral load

In this study, 2 cases were given to the head of the load to be able to see the different results in these 2 cases after being analyzed in the application.
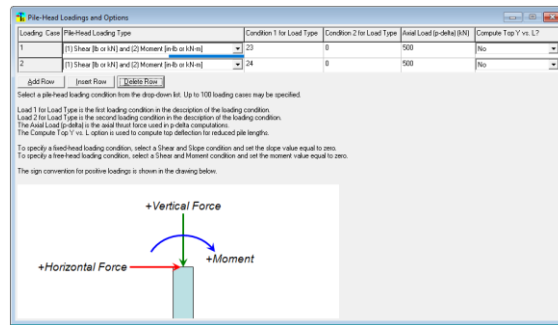

Fig 6. Pile head Loading

3. Enter soil data

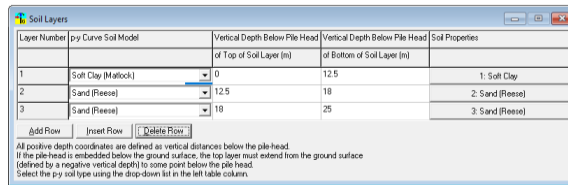In this data, the data included are soil type, base layer height and soil layer data.

Fig 7. Soil data

There are 3 layers of soil according to the picture above, each layer will enter data such as effective weight, undrained shear strength, ε50 following the depth of each.
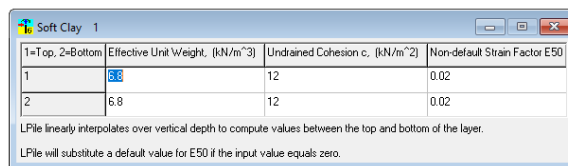

Fig 8. Soil Layer 1

Fig 9. Soil Layer 2

Fig 10. Soil Layer 4

The next stage after all data has been entered in the application is to analyze the application to issue the following results:
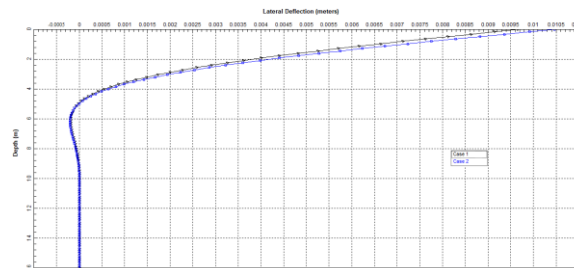
1. Lateral deflection vs Depth

Fig 11. Lateral deflection vs Depth

In the curve above, we can see the deflection of the pole in the first case with 23 kN loading of 9,651 mm. while the result of deflection in the second case the loading of 24 kN is 10.5 mm. Based on P2B Regulation No. 50/2007, a maximum permit deflection of free head poles is determined at 10 mm under 100% lateral load and 25 mm at 200% lateral load.

So from the results of the deflection of the pile in the first case it is safe, but in the second case the deflection of the pile has exceeded the permit deflection limit. This is caused because the pole is overloaded.
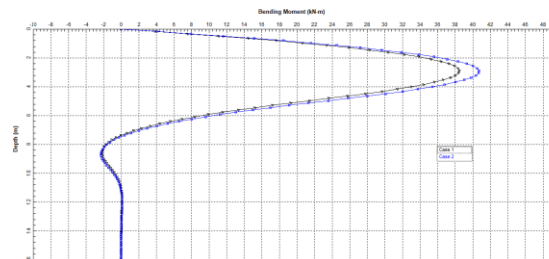
2. Moment vs Depth

Fig 12. Moment **vs Depth**

In the curve above, we can see the results of moments that occur for 2 cases in the first case, the maximum moment results are 38.4659 kN.m or 4.32 tons.m and in the second case the maximum moments are 40.7012 kN.m or 4.57 tons.m it is still fulfilling because the bending moment bending in the brochure is 7.5 tons with the 400 mm pole dimension

Moments that occur maximally <Crack Moments ... (OK) Then, the dimensions of this pile can be used as a plan.

5. Conclusion

By looking at the results of the research discussed above, we can draw the following conclusions:

1. The load that occurs on the pile's head should not be more than 23 kN because if more than that the deflection of the pile will exceed 10 mm can be seen in Figure 4.11 case 2 is a lateral load of 24 kN then the pile deflection is 10.5 already more than the maximum deflection that is allowable is 10 mm at 100% lateral load according to Regulation P2B No. 50 of 2007.

2. The maximum result of the moment that occurs must be checked with Mcrack first, if the maximum moment is greater in Mcrack must be replaced by the dimensions of the pole, while if the maximum moment is smaller than Mcrack then it is OK.

3. The maximum lateral load at which the pile is maintained is 23 kN

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