

## **ANALISIS PENURUNAN PONDASI TIANG *BORE PILE***

**(Studi kasus Pembangunan Klinik Be Hati Surakarta)**

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### **ABSTRAC**

Bored pile foundation is a type of foundation that is used to transfer loads from the structural part to the superstructure/superior to the subsoil below it until the desired bearing capacity is required, so that the construction part of the substructure/substructure is required without the risk of shear collapse or more settlement. The purpose of this study is to analyze the decrease in the bore pile foundation in the construction of the Be Hati Surakarta Clinic building with a building area of 2500 m<sup>2</sup>, where the calculation of the reduction in bore pile foundation is calculated based on 3 sondir points and 3 SPT points using empirical and semi-empirical methods, results from sondir data at point 1 with a value of  $S = 8.95$  mm, at point Sondir 2 with a value of  $S = 9.01$  mm, at point Sondir 3 with  $S = 8.92$  mm, results of analysis and calculation of pile bearing capacity based on data (SPT) at point 1 with a value of  $St = 28.71$  m, point (SPT) 2 with a value  $St = 30.77$  m, point (SPT) 3 with  $St = 27.86$  m. The results of the comparison of the calculation of the ultimate bearing capacity of the piles based on Sondir and Spt with an average  $St$  Spt value greater than the Sondir value with a difference of 79.17% and there is a correlation calculation relationship with the value of R-Square ( $R^2$ ) = 0.8762, it is included in the strong category.

Keywords: bore pile, foundation bearing capacity, sondir, spt, foundation settlement load

### **1. PENDAHULUAN**

The city of Surakarta is currently undergoing a lot of development including the construction of the Great Sheikh Zayed Mosque, Islamic Center, Joglo Simpang Underpass, one of which is the construction of the Be Hati health clinic. Location Prior to the construction of the BeHati Clinic, there used to be residential houses and stalls. Before carrying out the construction of this project, demolition of the building was carried out first and land clearing. The owner of the project is Mr. Dr. Khoirul Hadi, Sp.KK, apart from being used for a beauty clinic business, this building is also used as his residence. Budget Plan The cost of this project is estimated to cost around 5 billion. The executor of the Dr. Khoirul House construction project for Business is CV. Deconcept, with its main director, Mr. Tri Pratikno, S.T. the construction of the behati clinic building must be well planned to prevent failures in the building. The planning includes the planning of columns, beams, floor plates, foundations and also the roof frame of the building. The planning is also inseparable from the loads acting on the building, both in the form of dead loads, live loads, wind loads, and earthquake loads. The loads that occur on the building will be borne by the building structure and passed on to the foundation to be transferred to the ground. Civil engineering buildings in general include two general parts, namely the sub structure and the upper structure. The foundation is included in the lower structure and is the main support for a structure. The foundation as the basis

of the building must be able to carry the entire load of the building and other loads that are also taken into account and transmit it into the soil beneath it. If the soil is unable to carry the load of the foundation or has a small bearing capacity, excessive settlement or failure of the soil will occur. Both of these will cause damage to the structure above the foundation. In planning the foundation it is very important to analyze the bearing capacity of the foundation and the settlement of the foundation.

### **Rumusan Masalah**

Berikut merupakan rumusan masalah dalam penelitian:

1. How much settlement has occurred in the bore pile foundation based on the Standard Penetration Test (SPT) data?
2. How much settlement has occurred in the bore pile foundation using sondir data?
3. What is the comparison of the settlement of bore pile foundations based on Standard Penetration Test (SPT) data and sondir data?

### **Batasan Masalah**

Sesuai dengan latar belakang diatas, maka penelitian ini dibatasi sebagai berikut:

1. This research was conducted at the Be Hati Clinic Building Project in Surakarta City.
2. The data used to calculate the settlement of bore pile foundations is based on sondir results. NSPT data is calculated based on correlation with sondir data.
3. The calculation is only for the analysis of settlement of single piles and group piles.
4. Permit reduction based on SNI 8460:2017 geotechnical review.

### **Tujuan Penelitian**

Tujuan dari penelitian ini adalah:

1. Calculating the settlement that occurs in the bore pile foundation based on Standard Penetration Test (SPT) data.
2. Calculating the settlement of bore pile foundations using sondir data.
3. Analyzing the comparison of settlement of bore pile foundations based on Standard Penetration Test (SPT) data with sondir data.

### **Pondasi**

The foundation is part of the substructure which plays an important role in carrying the load on the superstructure. The load will be passed on to the soil under the foundation. The bearing capacity of the soil under the foundation must be able to withstand the load of the structure. If the soil is unable to carry the load of the foundation or has a small bearing capacity, excessive settlement or failure of the soil will occur. Both of these will cause damage to the structure above the foundation. The bearing capacity of the deep foundation and the amount of settlement of the foundation can be calculated based on soil data from laboratory tests or field tests.

### **Pondasi Bore Pile**

Bore pile is a deep foundation that is shaped like a long tube and is driven into the ground until it reaches the hard soil layer. Serves to continue the load of the structure of the building above it from the ground surface to the hard soil below.

Bore Pile foundations have the same function as piles or earth nails, but have differences in the process. The implementation of the bored pile foundation starts with making a hole into the ground by drilling the soil using a mini crane machine first, then proceed with the installation of the reinforcing iron assembly inserted into the drilled ground hole, then proceed with casting setmix / ready mix concrete. The bore pile foundation is a deep foundation that is shaped like a long tube and is driven into the ground. The purpose of using this foundation is so that the building can stand firmly after the construction process is complete. This bore pile foundation has types and benefits for building construction. The use of bore piles is enabled to channel heavy construction loads into the harder soil layers. The bore pile method is used if the surface structure is not strong enough to withstand the overall load of the building to be erected. The drilling method used to anchor the foundation uses a repeated drilling method with a low vibration level. Usually this foundation is used to secure multi-storey buildings or maintain the stability of buildings on slopes.

### **Keuntungan Pondasi Bore Pile**

Keuntungan dalam pemakaian tiang bor dibandingkan dengan tiang pancang adalah:

1. Improving the effectiveness of planned, measurable and integrated occupational safety and health protection.
2. Drilled piles can be installed through rock, while piles will have difficulty driving through rock layers.
3. No risk of land level rise
4. The diameter of the pile allows it to be made large, if necessary the lower end of the pile can be made larger in order to increase its bearing capacity.

### **Kerugian Pondasi Bore Pile**

Kerugian dalam pemakaian tiang bor dibandingkan dengan tiang pancang adalah:

1. If the quality of the poured concrete is not guaranteed uniformity along the body of the drilled pile reduces the bearing capacity of the drilled pile, especially if the drilled pile is deep enough.
2. Casting concrete is rather difficult if it is influenced by ground water because the quality of the concrete cannot be controlled properly
3. The casting of drilled piles is affected by weather conditions
4. Water flowing into the borehole may cause soil disturbance, thereby reducing the bearing capacity of the pile

### **Penurunan Pondasi**

Estimation of settlements that occur in pile foundations is a complicated problem caused by several factors, such as disturbances in the soil stress during driving and uncertainties regarding the distribution and position of load transfer from the piles to the ground. The settlement of the foundation in piles and bore piles when designed based on axial load bearing capacity considerations, is generally less than 0.5 inches.

### **3. METODE PENELITIAN**

#### **Metode penelitian**

The research method is an analysis of theory or science that discusses methods of conducting research. The method is basically the method used to achieve the goal. So the general purpose of research is to solve problems, then the steps to be taken must be relevant to the problems that have been formulated. The research method used in this study is a comparative and quantitative study method. In this study, the unit price coefficient values for materials, wages, and equipment from the concrete work on the project will be obtained, then the unit price for each method will be obtained, which will then be compared with the price values for the other methods.

#### **Lokasi penelitian**

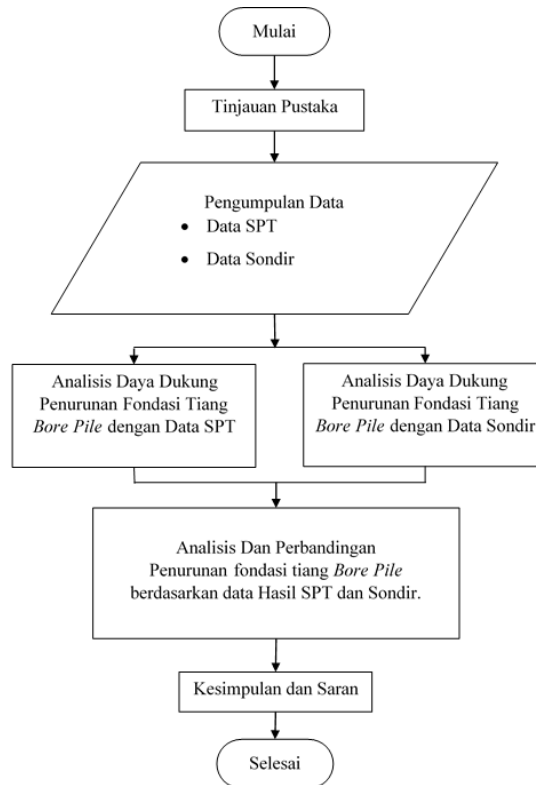
The research location is in the House for Business Development Project Dr. Khoirul, located on Jalan Dr. Sutomo No. 28 Surakarta Purwosari Village, Laweyan District, Surakarta City, Central Java Province

#### **Data Penelitian**

For the smoothness of this research, some data is needed to be used as a means to achieve the aims and objectives of the research. The required data is as follows:

1. Detailed drawing of the building  
Is the overall design of the building to be built, this image is obtained from the project planner.
2. Bore pile foundation plan
3. An illustration of the location of the position of the foundation that will be driven, obtained from the project planner.
4. Standard Penetration Test Data (SPT)
5. SPT data is secondary data originating from the laboratory archives of the Muhammadiyah University of Surakarta, Faculty of Engineering.
6. Sondir Data (DCPT)
7. Sondir data is secondary data originating from the laboratory archives of the Muhammadiyah University of Surakarta, Faculty of Engineering.

#### **Diagram Alir Penelitian**



Gambar 1 Bagan alir penyusunan penelitian

#### 4. PEMBAHASAN

##### Intermediate Result of Lowering Capacity of Bore Pile Foundation Based on Sondir with SPT.

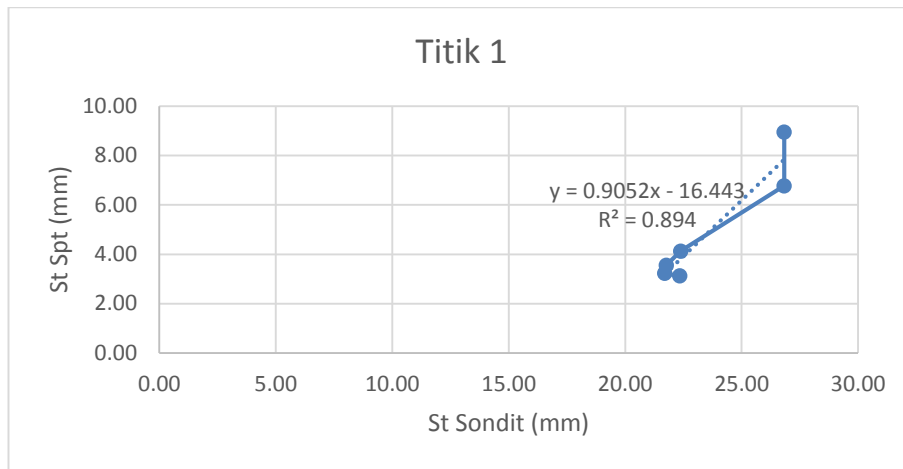
From the calculation of the settlement of bore pile foundation based on N-Spt at point 1 with Sondir at point 1 with an S N-Spt value of 26.83 mm, and a sondir S value of 8.92, the average N-Spt is greater than that of Sondir. Which has a difference of 17.88 mm with an average percentage of 79.64%. results can be seen in table 4.14 :

**Table 4. 14** Comparison of Qijin Sondir 1 with Spt 1

Depth m	N-Spt 1 (mm)	Sondir 1 (mm)	Selisih (kN)	Present %
1	22.35	3.12	19.23	86.04%
2	21.70	3.23	18.48	85.14%
3	21.76	3.55	18.21	83.69%
4	22.38	4.13	18.26	81.57%
5	26.83	6.77	20.05	74.76%
5.6	26.83	8.95	17.88	66.64%
<b>Rata - rata</b>				79.64%

Perhitungan ( $S_t$ ) SPT titik 1 dan ( $S$ ) Sondir titik 1 terdapat hubungan perhitungan dengan nilai R- Square ( $R^2$ ) = 0,894, maka termasuk dalam kategori kuat. Dan kemampuan hasil perhitungan ( $S_t$ )

SPT dan (S) Sondir dalam perhitungan persamaannya adalah  $y = 0,9052x - 16,443$  dan  $x = -16,443$ . Hasil dapat dilihat pada :



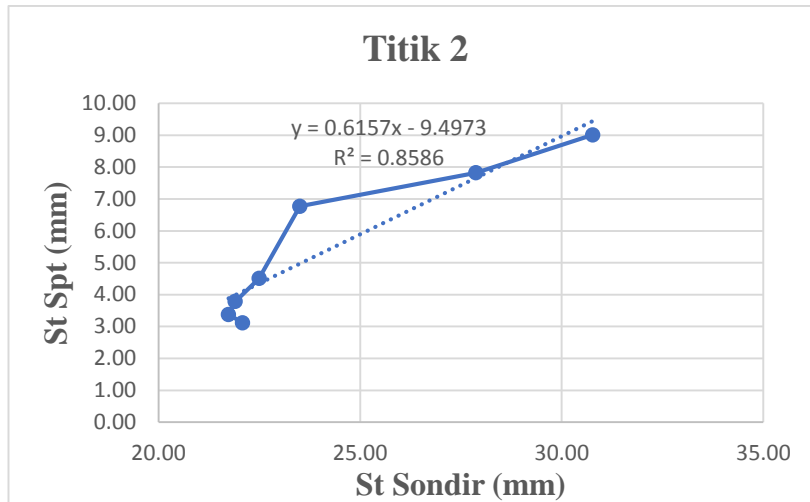
Gambar 4. 1 Grafik Data Sondir titik 1

Dari hasil perhitungan penurunan pondasi tiang *bore pile* berdasarkan N-Spt dititik 2 dengan Sondir dititik 2 dengan nilai S N-Spt 30,77 mm, dan nilai S sondir 9,01, maka rata – rata N-Spt lebih besar dibanding dengan Sondir. Yang mempunyai selisih 21,76 mm dengan rata – rata persent 78,12%. hasil dapat dilihat tabel 4.15

**Tabel 4. 1** Perbandingan  $Q_{ijin}$  Sondir 2 dengan Spt 2

Depth m	N-Spt 2 (mm)	Sondir 2 (mm)	Selisih (kN)	Present %
1	22.08	3.12	18.96	85.88%
2	21.73	3.38	18.36	84.46%
3	21.90	3.79	18.12	82.72%
4	22.49	4.51	17.98	79.95%
5	23.51	6.77	16.73	71.19%
6	27.87	7.82	20.05	71.94%
6.4	30.77	9.01	21.76	70.71%
<b>Rata - rata</b>				78.12%

Perhitungan (St) SPT titik 2 dan (S) Sondir dititik 2 terdapat hubungan perhitungan dengan nilai R- Square ( $R^2$ ) = 0,8586, maka termasuk dalam kategori kuat. Dan kemampuan hasil perhitungan (St) SPT dan (S) Sondir dalam perhitungan persamaannya adalah  $y = 0,6157x - 9,4973$ . Hasil dapat dilihat pada gambar 4.23



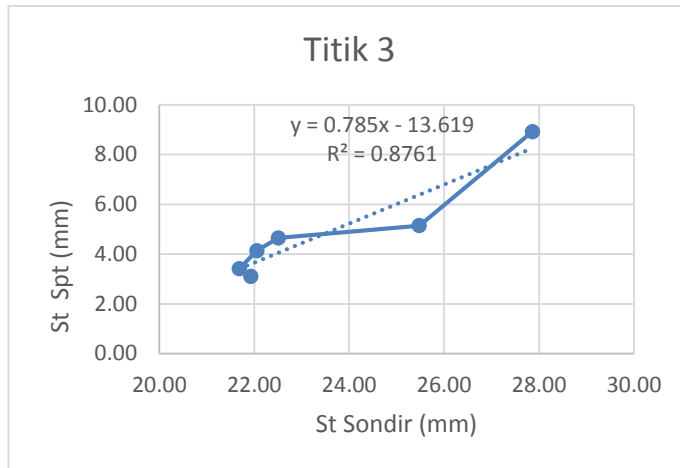
Gambar 4. 2 Grafik Sondir titik 2

Dari hasil perhitungan penurunan pondasi tiang *bore pile* berdasarkan N-Spt dititik 3 dengan Sondir dititik 3 dengan nilai S N-Spt 27,86 mm, dan nilai S sondir 8,92, maka rata – rata N-Spt lebih besar dibanding dengan Sondir. Yang mempunyai selisih 18,94 mm dengan rata – rata persent 79,75%. Hasil dapat dilihat tabel 4.16

**Tabel 4. 2** Perbandingan Qijin Sondir 3 dengan Spt 3

Depth m	N-Spt 3 (mm)	Sondir 3 (mm)	Selisih (kN)	penetration %
1	21.93	3.11	18.82	85.83%
2	21.68	3.40	18.28	84.30%
3	22.05	4.14	17.92	81.25%
4	22.51	4.65	17.86	79.34%
5	25.48	5.15	20.33	79.80%
5.6	27.86	8.92	18.94	67.98%
<b>Rata - rata</b>				79.75%

Perhitungan (St) SPT dititik 3 dan (S) Sondir dititik 3 terdapat hubungan perhitungan dengan nilai R- Square ( $R^2$ ) = 0,8761, maka termasuk dalam kategori kuat. Dan kemampuan hasil perhitungan (St) SPT dan (S) Sondir dalam perhitungan persamaan garisnya adalah  $y = 0,785x$  dan  $x -13,619$ . Hasil dapat dilihat pada gambar 4.24



Gambar 4. 3 Grafik Sondir titik 3

#### 4.1 Hubungan Perbandingan Antara Analisis Perhitungan Penurunan pondasi Bore Pile Berdasarkan Sondir dengan SPT

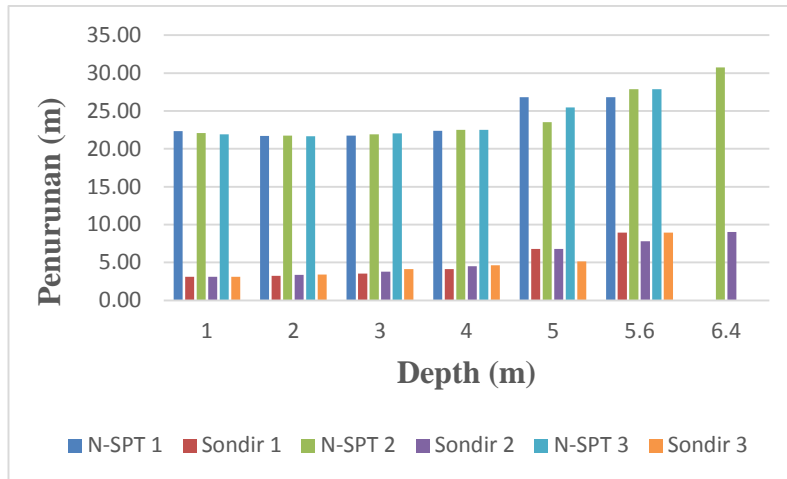
Dari hasil perhitungan penurunan pondasi tiang *bore pile* berdasarkan Sondir dititik 1-3 dengan Spt dititik 1-3 dengan rata – rata St spt lebih besar dari S. hasil dapat dilihat tabel 4.17

Tabel 4. 3 Perbandingan antar Spt 1 - 3

Depth m	N-Spt 1 (mm)	Sondir 1 (mm)	N-Spt 2 (mm)	Sondir 2 (mm)	N-Spt 3 (mm)	Sondir 3 (mm)
1	22.35	3.12	22.08	3.12	21.93	3.11
2	21.7	3.23	21.73	3.38	21.68	3.4
3	21.76	3.55	21.9	3.79	22.05	4.14
4	22.38	4.13	22.49	4.51	22.51	4.65
5	26.83	6.77	23.51	6.77	25.48	5.15
5.6	26.83	8.95	27.87	7.82	27.86	8.92
6.4	0	0	30.77	9.01	0	0

Hasil perhitungan kapasitas dukung tiang berdasarkan SPT dari titik 1-3 dan Sondir dari dititik 1-3 maka diketahui nilai St Spt lebih besar dari pada nilai Sondir. Dengan selisih 79.17%. Hasil dapat dilihat pada gambar 4.25





Gambar 4. 4 grafik Perbandingan Spt dan Sondir

## 5. PENUTUP

### Kesimpulan

Berdasarkan hasil pengamatan yang dilakukan, maka peneliti menarik kesimpulan sebagai berikut:

1. Hasil Penurunan tiang tunggal (S) pondasi *bore pile* berdasarkan data sondir dengan menggunakan metode empiris dengan (vesic,1970). dengan nilai S Sondir = 9.01 mm
2. Hasil Penurunan tiang tunggal (St) pondasi *bore pile* berdasarkan data SPT dengan menggunakan metode semiempiris dengan (vesic,1970). dengan nilai St SPT = 30,77 mm
3. Hasil perbandingan perhitungan penurunan pondasi berdasarkan Sondir dan Spt dengan rata-rata nilai St SPT lebih besar dibanding nilai Sondir dengan Selisih 32.02% dan terdapat hubungan perhitungan kolerasi dengan nilai *R-Square* ( $R^2$ ) = 0,9008 maka termasuk dalam kategori kuat.

### Saran

1. Perhitungan penurunan tiang pondasi bore pile dapat menggunakan metode-metode lain .
2. Penelitian selanjutnya dapat membandingkan penurunan menggunakan penelitian *software* yang konteks.

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