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ANALYSIS OF THE BEARING CAPACITY OF PILE FOUNDATIONS IN THE DESIGN AND CONSTRUCTION PROJECT OF AN ACCESS BRIDGE ACROSS THE CISADANE RIVER IN THE PIK-2 EXTENTION AREA

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ABSTRACT

A bridge is defined as a building construction structure that connects two tracks cut off due to rivers, lakes or other crossings. Bridges have an important role in facilitating the flow of vehicles. In construction definitely requires a foundation. The foundation is a construction that functions as a support above it. In general, bridges have two structural parts : the upper structure receiving direct loads and the lower structure carrying all the loads above it. The upper structure consists of a curb, vehicle floor plate (slab), main beam and diaphragm beam. While in the lower structure there are abutments and pillars, the construction of a bridge definitely requires analysis and calculation, the purpose of making a journal is to calculate the carrying capacity of pilecap foundations, piles, with soil carrying capacity using NSPT and get results on each calculation of the maximum load of piles with qualified soil that is greater than Qall da=with example P1 which is 47.279 tons/pole < Qall = 47.28 tons (OK), P2 which is 47.274 tons/pole < Qall = 47.28 tons (OK), P3 which is 47.268 tons/pole < Qall = 47.28 tons (OK). From these calculations, it can be concluded that the pilecap with 45 piles with a diameter of 80 cm is able or safe to support the construction on it.

1. INTRODUCTION

A bridge is defined as a building construction structure that connects two tracks cut off due to rivers, lakes or other crossings. Bridges have an important role in facilitating the flow of vehicles. One is the Cisadane river bridge in the Pik 2 extention area. This 604,650 m long bridge connects Teluk Naga District with Pakuhaji District. Basically, the bridge must have a strong foundation structure. Then the planning of the foundation structure must be planned as well as possible.

The foundation is a construction that functions as a support that is above it. In general, bridges have two structural parts, namely the upper structure that receives direct loads and the lower structure that functions to carry all the loads above it. The upper structure consists of a curb, vehicle floor plate (slab), main beam and diaphragm beam. While in the lower structure there are abutments and pillars. (Wiqoyah &; Nugroho, 2022)

The construction of a bridge certainly requires data and analytical calculations about the land. Land is the most important part of civil engineering development, in terms of supporting buildings and retaining buildings, so the land must exceed the requirements. (Permatasari, 2018)

The bearing capacity of piles is obtained from the carrying capacity of the end obtained from the pressure of the end of the pile and the carrying capacity of shear or blankets obtained from the bearing capacity of friction or adhesion forces between the pile and the surrounding ground. Determining the type of foundation to be used needs to consider several factors, namely, soil type faltor, soil hardness factor and load factor to be carried. On clay soils have a hard soil layer located at a relative depth in this case it is very suitable to use pile foundations in the construction of this bridge. The selection of the method used for testing is carried out, namely the NSPT test. (Fahriani &; Apriyanti, 2015)

According to Coduto (1994) there are 3 (three) supporting parts of pile foundations, including *static* methods (using classical soil mechanics principles), *dynamics*, and load loading tests (full-scale load tests). The way piles are burdened by the physical and mechanical properties of the soil both for its properties and the values of c (*cohesion*), Ø (deep shear angle), γ (unit weight of soil). (Randyanto et al., 2015)

As a result of beheading, the bearing capacity of the pile can be affected.the maximum load capacity is determined by the calendaring test using the Hiley method. the greatest reduction is observed with the *Hiley* method. Pile foundation load capacity analysis is confirmed by pile *driving analyzer* test and *capwap* test results. (Yusti & Fahriani, 2014)

In this study, what will be discussed is about the carrying capacity of pile foundations in the Cisadane River Bridge Construction project in the PIK 2 Extension Area. At the construction site of this bridge is on the coast and contains clay soil. The foundation that is suitable for use in this construction is a pile foundation. With 15 m, 15m and 10 m Length configurations.

Piling Foundation

Foundation *Piles* are a structural part of a building that functions as a gravitational divider evenly on the ground. The pile foundation has the shape of a tube or cylinder. Making these piles by precast or assembly is reinforced concrete that is pressed and poured into concrete molds and after being strong enough just lifted

This *pile* foundation is widely used in soil structures that have the possibility to shift such as in coastal areas or swamps. (Kusuma &; Lestari, 2021)

Data NSPT

SPT was originally used to determine the density of coarse-grained soils and as a way to determine the consistency of fine-grained soils. When testing the geological structure of the soil, the pore number (*e*), moisture content in a saturated state (*w*), dry volume weight and soil specific gravity are known (*Gs*). This test will produce calculations for the depth of the pole to be used and the bearing capacity of the pole and its shear resistance. (Eriyanto et al., 2017; Yusti & Fahriani, 2014)

Maximum load on the mast group

The loadcaused from above and in a single pole will cause compressive or tensile forces. So the piles need to be monitored so that each pile can still withstand the load of the building above it. The axial load and moment from above will be channeled towards the pilecap and also towards the unity of the pile. This will not cause cracks or cause tilting or deformation. To find the maximum and minimum load on a single pile can be through the equation (Pamungkas and Harianti)

$$Pmax = \frac{Pu}{Np} \pm \frac{My.Xmax}{Ny..\Sigma x^2} \pm \frac{Mx.Xmax}{Ny.\Sigma y^2} \quad (1)$$

With :
P max = maximum load of the pole
Pu = axial force occurring
My = moment that works perpendicular to the y-axis
Mx = moment acting perpendicular to the x-axis
X max = farthest x-axis direction pole distance
Y max = distance of the farthest y-axis direction pole
Σx^2 = sum of squares of X
Σy^2 = sum of squares Y
nx = many poles in one row of the x-axis direction
ny = many poles in one row of y-axis direction
NP = Number of poles

When the maximum P shows a positive value, then the pilcape acquires a compressive force. If the maximum P shows a negative value, then the pilecape acquires a pulling force. Therefore, it can be seen that each stake still meets the compressive and tensile carrying capacity or not.

Pilecap

Pilecap is as a fastener for all piles to make them in one unit in order to channel the load from the upper structure to the lowest structure. The size of the pilecap depends on the number of piling points and the distance between piles.

2. METHOD

The location used in this study is located in the Pik 2 Extension area, Tanjung Burung Village and Kohod Village, Teluknaga and Pakuhaji Districts, Tangerang Regency, Banten. At this research location, soil carrying capacity tests will be carried out with sondir test equipment and refer to SNI 2827:2008 standards.

Then from the sondir data that has been calculated can determine the effectiveness of piles and pilecap width. It can also analyze the foundation decline that occurs in the region.

3. RESULTS AND DISCUSSION

Calculating Foundation Carrying Capacity

NSPT test results at point P1 reached a depth of 35 m.
The data obtained from the 35 meter depth test are:
Mast Carrying Capacity (RMX), qc = 387 tons/flow with 28 flows/m
Ground Ultimate lower end (Qb) = 91.61 KN
Ultimate Friction Resistance (Qs) = 1377.03 KN

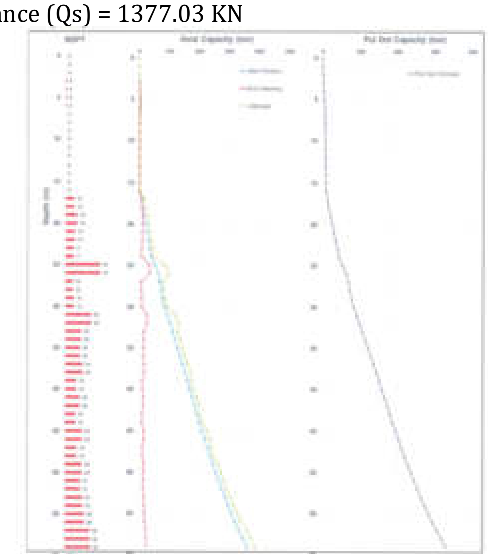

Figure 1. NSPT Mast Bearing Capacity Picture

a. Piling Area (AP)
   $Ap = {}^{1}/_{4} \times \pi \times D^2$
   $= \times\ {}^{1}/_{4}\ 3.14 \times 0.8^2$
   $= 0.502\ m^2$
b. Piling Circumference (USA)
   As= π x D2
   $= 3.14 \times 0.8^2$
   $= 2.512\ m^2$
c. Ultimate Carrying Capacity (Qu)
   Qu= Qb+Qs
   = 91.61 + 1377.03
   = 1422.84 KN
   $Qall = \frac{Qu}{SF}$
   $= \frac{1422{,}84\ KN}{3}$
   = 474.28 KN
   =47.428 tons
d. Number of Columns
   (Column Load 2124.23 tons)
   $= \frac{Beban\ Kolom}{Qall}$
   $= \frac{2124{,}23}{47{,}428}$
   = 44,715 poles

Tried pole count 45

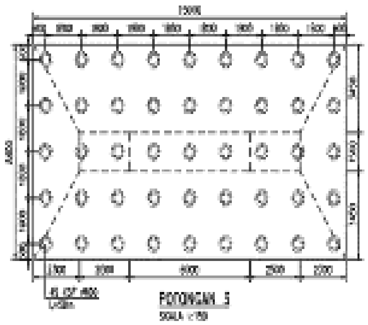

Figure 2. Piling Plan Drawing

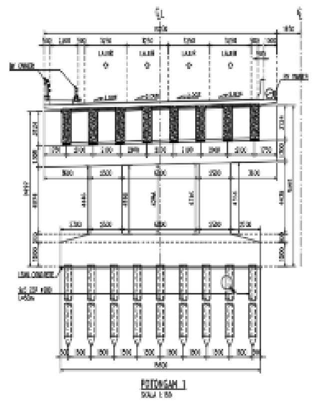

Figure 3. Cutout Image of A Pile

Cut Drawing B Piles

e. Carrying Capacity permits Mast group
Used number of poles 45, with m=9, n=5
eng= $1-\left[\frac{n-1.m+(m-1).n}{90.m.n}\right] x\ Ø$
= 0.89356
Pg= Eg x Np x Qall
= 2282,442
Pg > Pu
2282,442 > 2124,23 (Safe)

f. Max load of the pole on the group pole
Known data :
Pu= 2124.23 tons
Mx= 192.76
My= -132.65
X1= -7.2
X2= 7.2
Y1= -3.2
Y2= 3.2
ΣX^2 = 8748 m^2
ΣY^2 = 1458 m^2
Nx= 9
ny= 5
N= 45

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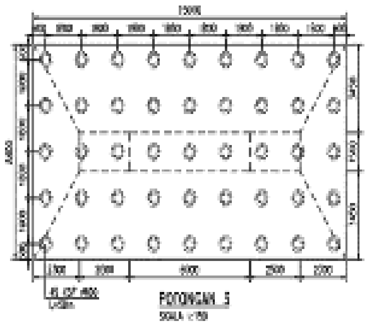

Figure 4. Stake Planning Drawing on P1 pilecap

$Pmax = \frac{Pu}{Np} \pm \frac{My.Xmax}{Ny..\Sigma x^2} \pm \frac{Mx.Xmax}{Ny.\Sigma y^2}$

$P1 = \frac{2124{,}23}{45} \pm \frac{955{,}08}{43740} \pm \frac{693{,}936}{13122}$

= 47.279 tons/pole < Qall = 47.28 tons (OK)

$P2 = \frac{2124{,}23}{45} \pm \frac{716{,}31}{43740} \pm \frac{693{,}936}{13122}$

= 47.274 tons/pole < Qall = 47.28 tons (OK)

$P3 = \frac{2124{,}23}{45} \pm \frac{477{,}54}{43740} \pm \frac{693{,}936}{13122}$

= 47.268 tons/pole < Qall = 47.28 tons (OK)

$P4 = \frac{2124{,}23}{45} \pm \frac{238{,}77}{43740} \pm \frac{693{,}936}{13122}$

= 47.263 tons/pole < Qall = 47.28 tons (OK)

$P5 = \frac{2124{,}23}{45} \pm \frac{0}{43740} \pm \frac{693{,}936}{13122}$

= 47.257 tons/pole < Qall = 47.28 tons (OK)

$P6 = \frac{2124{,}23}{45} \pm \frac{-238{,}77}{43740} \pm \frac{693{,}936}{13122}$

= 47.252 tons/pole < Qall = 47.28 tons (OK)

$P7 = \frac{2124{,}23}{45} \pm \frac{-477{,}54}{43740} \pm \frac{693{,}936}{13122}$

= 47.2 47 tons/pole < Qall = 47.28 tons (OK)

$P8 = \frac{2124{,}23}{45} \pm \frac{-716{,}31}{43740} \pm \frac{693{,}936}{13122}$

= 47.241 tons/pole < Qall = 47.28 tons (OK)

$P9 = \frac{2124{,}23}{45} \pm \frac{-955{,}08}{43740} \pm \frac{693{,}936}{13122}$

= 47.236 tons/pole < Qall = 47.28 tons (OK)

$P10 = \frac{2124{,}23}{45} \pm \frac{-955{,}08}{43740} \pm \frac{346{,}968}{13122}$

= 47.236 tons/pole < Qall = 47.28 tons (OK)

$P11 = \frac{2124{,}23}{45} \pm \frac{-71631}{43740} \pm \frac{346{,}968}{13122}$

= 47.215 tons/pole < Qall = 47.28 tons (OK)

$P12 = \frac{2124{,}23}{45} \pm \frac{-477{,}54}{43740} \pm \frac{346{,}968}{13122}$

= 47.236 tons/pole < Qall = 47.28 tons (OK)

$P13 = \frac{2124{,}23}{45} \pm \frac{-238{,}77}{43740} \pm \frac{346{,}968}{13122}$

= 47.226 tons/pole < Qall = 47.28 tons (OK)

$P14 = \frac{2124{,}23}{45} \pm \frac{0}{43740} \pm \frac{346{,}968}{13122}$

= 47.231 tons/pole < Qall = 47.28 tons (OK)

$P15 = \frac{2124{,}23}{45} \pm \frac{238{,}77}{43740} \pm \frac{346{,}968}{13122}$

= 47.237 tons/pole < Qall = 47.28 tons (OK)

$P16 = \frac{2124{,}23}{45} \pm \frac{477{,}54}{43740} \pm \frac{346{,}968}{13122}$

= 47.242 tons/pole < Qall = 47.28 tons (OK)

$P17 = \frac{2124{,}23}{45} \pm \frac{716{,}31}{43740} \pm \frac{346{,}968}{13122}$

= 47.247 tons/pole < Qall = 47.28 tons (OK)

P18 = $\frac{2124,23}{45} \pm \frac{955,08}{43740} \pm \frac{346,968}{13122}$
= 47.253 tons/pole < Qall = 47.28 tons (OK)
P19 = $\frac{2124,23}{45} \pm \frac{955,08}{43740} \pm \frac{0}{13122}$
= 47.226 tons/pole < Qall = 47.28 tons (OK)
P20 = $\frac{2124,23}{45} \pm \frac{716,31}{43740} \pm \frac{0}{13122}$
= 47.2 21 tons/pole < Qall = 47.28 tons (OK)
P21 = $\frac{2124,23}{45} \pm \frac{477,54}{43740} \pm \frac{0}{13122}$
= 47.216 tons/pole < Qall = 47.28 tons (OK)
P22 = $\frac{2124,23}{45} \pm \frac{238,77}{43740} \pm \frac{0}{13122}$
= 47.210 tons/pole < Qall = 47.28 tons (OK)
P23 = $\frac{2124,23}{45} \pm \frac{0}{43740} \pm \frac{0}{13122}$
= 47.205 tons/pole < Qall = 47.28 tons (OK)
P24 = $\frac{2124,23}{45} \pm \frac{-238,77}{43740} \pm \frac{0}{13122}$
= 47.199 tons/pole < Qall = 47.28 tons (OK)
P25 = $\frac{2124,23}{45} \pm \frac{-477,54}{43740} \pm \frac{0}{13122}$
= 47.194 tons/pole < Qall = 47.28 tons (OK)
P26 = $\frac{2124,23}{45} \pm \frac{-716,31}{43740} \pm \frac{0}{13122}$
= 47.188 tons/pole < Qall = 47.28 tons (OK)
P27 = $\frac{2124,23}{45} \pm \frac{-955,08}{43740} \pm \frac{0}{13122}$
= 47.183 tons/pole < Qall = 47.28 tons (OK)
P28 = $\frac{2124,23}{45} \pm \frac{-955,08}{43740} \pm \frac{-346,97}{13122}$
= 47.156 tons/pole < Qall = 47.28 tons (OK)
P29 = $\frac{2124,23}{45} \pm \frac{-716,31}{43740} \pm \frac{-346,97}{13122}$
= 47.162 tons/pole < Qall = 47.28 tons (OK)
P30 = $\frac{2124,23}{45} \pm \frac{-477,54}{43740} \pm \frac{-346,97}{13122}$
= 47.167 tons/pole < Qall = 47.28 tons (OK)
P31 = $\frac{2124,23}{45} \pm \frac{-238,77}{43740} \pm \frac{-346,97}{13122}$
= 47.173 tons/pole < Qall = 47.28 tons (OK)
P32 = $\frac{2124,23}{45} \pm \frac{0}{43740} \pm \frac{-346,97}{13122}$
= 47.178 tons/pole < Qall = 47.28 tons (OK)
P33 = $\frac{2124,23}{45} \pm \frac{238,77}{43740} \pm \frac{-346,97}{13122}$
= 47.1 84 tons/pole < Qall = 47.28 tons (OK)
P34 = $\frac{2124,23}{45} \pm \frac{477,54}{43740} \pm \frac{-346,97}{13122}$
= 47.189 tons/pole < Qall = 47.28 tons (OK)
P35 = $\frac{2124,23}{45} \pm \frac{716,31}{43740} \pm \frac{-346,97}{13122}$
= 47.195 tons/pole < Qall = 47.28 tons (OK)
P36 = $\frac{2124,23}{45} \pm \frac{955,08}{43740} \pm \frac{-346,97}{13122}$
= 47,200 tons/pole < Qall = 47.28 tons (OK)
P37 = $\frac{2124,23}{45} \pm \frac{955,08}{43740} \pm \frac{-693,94}{13122}$
= 47.174 tons/pole < Qall = 47.28 tons (OK)
P38 = $\frac{2124,23}{45} \pm \frac{716,31}{43740} \pm \frac{-693,94}{13122}$
= 47.168 tons/pole < Qall = 47.28 tons (OK)
P39 = $\frac{2124,23}{45} \pm \frac{477,54}{43740} \pm \frac{-693,94}{13122}$
= 47.163 tons/pole < Qall = 47.28 tons (OK)
P40 = $\frac{2124,23}{45} \pm \frac{238,77}{43740} \pm \frac{-693,94}{13122}$
= 47.203 tons/pole < Qall = 47.28 tons (OK)

P41 = $\frac{2124,23}{45} \pm \frac{0}{43740} \pm \frac{-693,94}{13122}$
= 47.152 tons/pole < Qall = 47.28 tons (OK)
P42 = $\frac{2124,23}{45} \pm \frac{-238,77}{43740} \pm \frac{-693,94}{13122}$
= 47.147 tons/pole < Qall = 47.28 tons (OK)
P43 = $\frac{2124,23}{45} \pm \frac{-477,54}{43740} \pm \frac{-693,94}{13122}$
= 47.141 tons/pole < Qall = 47.28 tons (OK)
P44 = $\frac{2124,23}{45} \pm \frac{-716,31}{43740} \pm \frac{-693,94}{13122}$
= 47.136 tons/pole < Qall = 47.28 tons (OK)
P45 = $\frac{2124,23}{45} \pm \frac{-955,08}{43740} \pm \frac{-693,94}{13122}$
= 47.13 tons/pole < Qall = 47.28 tons (OK)

4. CONCLUSION

Based on the analysis of pile foundation calculations, a value (PU) of 2124.23 tons was obtained. Based on the analysis, the value (Qu) was 1422.84 tons and the Qall value was 47.28 tons. On all poles, Pmax is less than Qall. Then the structure is categorized as safe. Based on the analysis of the calculation of the carrying capacity of the pile group permit with a total of 45 poles, a value of 2282.442 tons is greater than the working value of 2124.23 tons so that the structure is categorized as safe.

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