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Modification Model of Pile Foundation Due To Additional Ground Water Tank

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Abstract

The office buildings located in Palembang has a plan for 4 floors building. The building construction system changed due to the addition of the ground water tanks (GWT). The most influential changed in the structure is on pile foundation. To get the elevation depth of GWT, the ground should be dug to a depth that is expected. Pile foundation used to support the building when the hard layer is deep inside the ground. The foundation of this type can also be used to support the building resist upward lifting force, especially in buildings that are influenced overthrow level due to the wind load. Masts also are used on supporting the building dock. At this building, poles have been affected by the forces of the collision of ships and water waves (Hardiyatmo, 2002). The analysis is to determine the magnitude of the load on the structure for the plan under or foundation structure. The calculation of the foundation structure uses a combination of loading 1DL + 1 LL (factored load). Pile was initially driven at 13.5 meters at the qc = 120 kgf/m. Design changed and the addition of ground of water tank causes the piles just as deep as 5 meters so the friction of pile capacity was reduced. Carrying capacity of a small friction causes the carrying capacity of the foundation is not able to withstand the axial load of the upper structure. The addition of piles at the same depth (5 meters) analized only on the foundation of the group that does not meet the needs of its carrying capacity. The addition of a pile depth of 5 meters to 11 meters with N-SPT value of 43 (on a soil depth of 19 m), leading into a large pile bearing capacity. Pile with a depth of 11 meters with the appropriate amount of advance planning is able to withstand the axial bearing capacity of the structure above. The ratio of the concrete due to addition of the pile with a depth of 5 meters is 1.9%. The ratio of the depth of concrete due to the addition of piles 11 meters is 2.2%. Increasing the number of piles is more efficient than the addition of depth piles for 0.3%.

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Keywords: foundation; piles; GWT; ratio; concrete; volume; depth; n-spt

1. Background

The office buildings located in Palembang has a plan for 4 floors building. This building was not designed for GWT. In development, the design are changed by adding GWT, for the purposes of sanitary and hydrant. The addition of ground water tanks are causing changes to the structure of the system, especially in the foundation system. Under the structure, there is also a basement, it is necessary to study due to the addition of the GWT. Changes in the structure of the most influential is the pile foundation structure. To get the elevation depth of ground water tank, the soil must be dug to a depth that is expected. In addition the GWT, the piles must be cut again until the required elevation. This resulted in a short pile and the friction of pile is reduced thus affecting the carrying capacity of the pile foundation. The objectives of this study are 1) to determine the effect of ground water tank to the foundation structure; 2) to obtain the most appropriate modeling with the conditions; 3) in order to compare the model 1 and model 2 is based on the calculation of the volume of concrete from both modeling.

In order for this research remains focused and does not extend the necessary restrictions on the problem:

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1) Structure of ground water tank uses reinforced concrete with concrete quality K-350 and reinforcing steel fy 400 Mpa.
2) Pole stake uses minipile 25x25 cm2 and quality of concrete K-400.
3) Analysis of the foundation structure uses two models, namely:
   a. Model 1: increasing the number of piles.
   b. Model 2: adding depth of piles.
4) Analysis of the building to get a load of the foundation uses ETABS program.
5) Analysis of the structure uses ETABS program just to get the factored load on the column.
6) Imposition is used to take dead load and live load (load factored).
7) Foundation was reviewed only at affected ground water tank.
8) The calculation of the carrying capacity of the land uses secondary data, drill logs and CPT.
9) Analysis of the addition of depth of piling uses data of drill log.
10) Analysis of the structure is to get a foundation bearing capacity and decline.
11) Addition of pile foundation analysis does not take into account the concrete volume due to enlarged pile cap.
12) Comparison of model 1 and model 2 refers to the volume of concrete used.
13) The analysis did not calculate reinforcement.
14) The analysis does not take into account changes in the foundation material and wages

2. Modeling

2.1. Model 1: increasing the number of piles

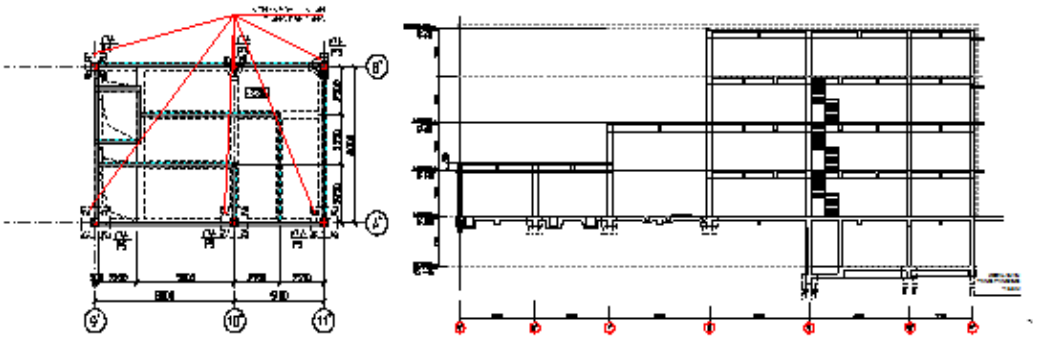

Fig. 1. Model 1: increasing the depth of piles

3. The Deep Foundation

Pile foundations which are a foundation structure that can withstand style orthogonal to the axis a pole with absorb diffraction. Pile foundation is made into a whole a monolith by uniting the base of the pile that are under construction with the pedestal of the foundation (K .Nakazawa , 1983).

Pile foundation is used for some mean, among others:

1. To forward building constructions which is located over water or land soft to the ground supporters that are strong.

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2. To forward burden to the ground relatively soft to certain depth, so building is able to provide sufficient support to support this burden by friction the wall a pole with of the surrounding land.
3. To anchor building is affected by force raised over resulting from pressure hydrostatic or moment overthrow.
4. To hold force horizontal and the forces her sloping.
5. In order to compress the burning sand, so that capacity supports the increase in land.
6. To support foundations of buildings whose surface land easy gradually crushed water (Hardiyatmo, 2002).

3.1. The axial capacity of pile

Axial capacity is the power pole in receives the maximum load. The power support axial permission is the utmost strength the pile in receives the load which then multiplied by a factor reduction to reduce the risk collapse.

Pile foundation can be divided into:

1. Pile is driven until the layer of soil hard, so that capacity land for foundations of this was more focused on end bearing. This type of pile called end bearing piles or point bearing pile. The end of a pile must be located on the land hard.
2. When no pile reached the layer of soil hard, so for hold burden received the stake, mobilization of prisoners most inflicted by the friction between piles ground without (skin friction). Piles like this called friction pile.

3.2. Calculation the number of piles

Calculation the number of the required on one point column uses burden axial by a combination burden DL + LL (load factor). The number of the necessary is calculated by dividing style axial occurring with capacity pile.

np = which :
np = The number of piles
P = Axial style that occurs
Pall = Capacity the end of a pile

3.3. Efficiency group pile

Calculation the number of the necessary is not perfect because of the pile support group does not mean that capacity one mast multiplied of the number of pole. This happens because of intervention of a tension line of the piles that close together (group action). Reduction capacity group pile caused by group action is usually expressed in one point efficiency.
Calculation efficiency group pile based on the Converse-Labbarre formula of Uniform Building Code AASHTO is:

Eg = which:
Eg = The efficiency of a group piles
Θ = arc tg (D/s)
D = Size cross section pile
S = The distance between pile
m = The number of pile in 1 column
n = The number of pile in 1 line

Capacity vertical group pile = Eg x number pile x capacity permission pile. Capacity group pile have to > force axial occurring.

4. Settlement

According to Poulus and Davis (1980), the reduction in long-term for foundations of a pile does not need to reviewed because of a decrease in the due to consolidate of the land of relatively small. This happens because of pile foundation planned to strong support end and strong support friction or sum of both of them (Hardiyatmo, 2002).

Estimated of a pile settlement can be calculate based on :

a. a buoyant pile or friction pile

$$S = \frac{Pu.I}{E_s.d}$$

with $I = I_o \cdot R_k \cdot R_h \cdot R\mu$

b. an end bearing pile

$$S = \frac{Pu.I}{E_s.d}$$

with $I = I_o \cdot R_k \cdot Rb \cdot R\mu$ which :

S = The settlement in the tops of the piles
Pu = Load factor works
I_o = Factors the influence of a decrease in the that is not easily compressible
R_k = Factor correction compressibility
R_h = Factors correction for the thickness of the layer located on the ground hard
R_μ = Factors correction the poisson μ
R_b = Factors correction to stiffness layers of supporting
h = The depth of the total the subsoil of the end of a pile to the ground
d = Diameter piles

5. Data of the building

The stage to start the process of analysis is collecting data regarding, such as a drawing sketch and size of the columns and beams, high between the floor and etc. And the datas will be inputted in ETABS software.

The building that will be analyzed has the following data :

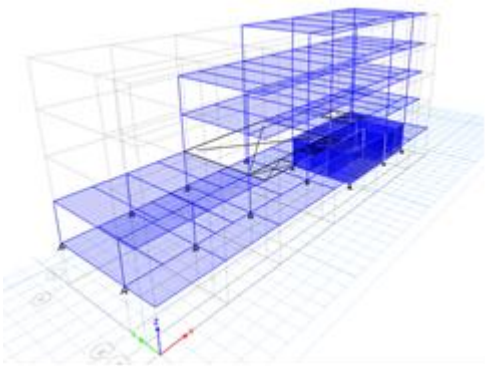

Fig. 2. Model of building structure

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5.1. Regulation and Standards

1) The procedures of the imposition of planning for the home and the building (SNI 03-1727-1989-F).
2) Procedures of calculation structure concrete to the building (SNI 03-2847-1992).

On things that did not stipulated in the regulation and standards above can refer the regulations and standards:

1) Building Code Requirements for Structural Concrete (ACI 318-95)
2) Uniform Building Code (UBC)

6. The Results of the Analysis

Analysis undertaken in the building is to know the burden structure over to plan structure down or the foundation. For calculation foundation structure combination imposition 1DL + 1 LL (the load factor). The results of the analysis for software ETABS is:

Table 1. Results analysis reaction for column

Story	Point	Load	FX (ton)	FY (ton)	FZ (ton)	Mmax
BASE	2	COMB1	-1,71	-2,72	173,09	1,43
BASE	4	COMB1	4,33	0,31	95,26	6,22
BASE	6	COMB1	-0,82	-16,62	367,98	2,28
BASE	31	COMB1	-0,43	1,48	229,47	1,15
BASE	32	COMB1	12,36	17,51	178,05	6,22
BASE	44	COMB1	-2,45	-0,05	454,96	2,28

6.1 Comparison Volume Concrete In Increase In The Number Of The Piles

Of the results of the analysis capacity and decrease in the pile foundation at the depth of 13.5 meters, or the number of piles and volume concrete as follows :

Table 2. The ratio of concrete at depth pile 13.5 meters:

Point	Number of the earlier pile (bh)	Number of the newer pile, l=5m (bh)	Volume of concrete		
			earlier (m3)	new (m3)	(%)
2	4	5	1,25	1,5625	1,3
4	3	3	0,9375	0,9375	1,0
6	3	12	0,9375	3,75	4,0
31	5	7	1,5625	2,1875	1,4
32	5	6	1,5625	1,875	1,2
44	5	15	1,5625	4,6875	3,0

Sum	25	48	7,8125	15,00	1,9

From table above it can be concluded with increasing the number of piles at the depth of land 13.5 meters, the ratio concrete increase 1.9 %.

6.2 Comparison Volume Concrete To Adding The Depth Of The Piles

Of the results of the analysis capacity and decrease in pillars foundation land at a depth of 19 meters with the number of the stake the volume of existing concrete obtained is as follows :

Table 3. The ratio of concrete at the depth of the 19 meters

Point	Number of the earlier pile (bh)	Number of the newer pile, l=5m (bh)	Volume of concrete		
			earlier (m3)	new (m3)	(%)
2	4	4	1,25	2,75	2,2
4	3	3	0,9375	2,0625	2,2
6	3	3	0,9375	2,0625	2,2
31	5	5	1,5625	3,4375	2,2
32	5	5	1,5625	3,4375	2,2
44	5	5	1,5625	3,4375	2,2
Sum	25	29	7,8125	17,188	2,2

From table above it can be concluded that by the addition of the depth of pole the ratio concrete increase 2.2 %.

7. Conclusion

Based on the analysis that has been done, can be concluded that :

1. The addition of the pile at the same depth (5 meters) only on the foundation group which of capacity support does not meet the needs.
2. The addition of the depth of piles of 5 meters to 11 meters with value N-SPT 43 (at the depth of land 19 m), causes capacity pile increased.
3. The ratio concrete due to increase in the number of piles by depth of 5 meters is 1.9 %.
4. The ratio concrete due to the addition of the depth of the stake 11 meters was 2.2 %.
5. Increase in the number of the piles is more efficient than the addition of the depth of piles for 0.3 %.

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