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DESIGN OF PILE FOUNDATIONS ON THE MITRA KASIH SCHOOL BUILDING BANJARMASIN

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ABSTRACT

The increasing population growth means that the need for education is also increasing. This is what encourages the provision of public infrastructure to support community education, one of which is a school building. The Mitra Kasih Banjarmasin Middle School building is a junior high school built at Citraland Jalan A. Yani KM 7.8 Banjarmasin, South Kalimantan. To support the building, of course, requires the design of the foundation. Selection of the type of foundation is based on the load to be received by the foundation, soil conditions, load conditions, dynamic properties of the superstructure, and others. Banjarmasin itself is an area with soft soil conditions. One solution that is often used in building structures on soft soils is pile foundation. This research was conducted to obtain the results of the load that will be received by the substructure based on calculations with ETABS software, determine the external load, bearing capacity, and the total number of foundation piles and obtain a DED (Detailed Engineering Design) and RAB (Budget Budget Plan). From the results obtained based on the analysis, a spun pile with a diameter of 500 mm and a length of 35 m was used with an axial pile resistance of 880 kN and a lateral resistance of 59.46 kN. Three types of pile caps were obtained with configurations of 5 piles, 6 piles and 7 piles with a total of 144 piles. Factored axial force 2827.95 kN; 3355.16 kN; and 4355.83 kN. Reinforcement diameter of 19 mm is used for flexural reinforcement, and a diameter of 13 mm for shrinkage reinforcement in the pile cap. The recapitulation of the budget plan for the pile work is Rp.5,758,130,889.-.

Keywords: *Pile, Pile Cap, Bearing Capacity, Budget Plan*

1. INTRODUCTION

The increasing population growth means that the need for education is also increasing. This is what encourages the provision of public infrastructure to support community education, one of which is a school building. The Mitra Kasih Banjarmasin Middle School building is a junior high school built at Citraland Jalan A. Yani KM 7.8 Banjarmasin, South Kalimantan. The Mitra Kasih Middle School Building Project itself was built on an area of 1948 m² and consists of 4 floors. To support the building, of course, requires the design of the foundation. The foundation can be interpreted as part of the structure that transmits the building load to hard soil or rocks that are relatively far from the surface. Banjarmasin itself is an area with soft

soil conditions, so that in planning a building structure, the foundation must be taken into account so that it can support the load on it and be able to transfer the load to the ground properly. One solution that is often used in building structures on soft soils is the pile foundation. According to SNI 8640-2017, the main function of a pile foundation is to transfer the load to a deeper layer of soil that can carry the workload with an adequate factor of safety so that it does not collapse and without causing settlement which can reduce the function of the structure it carries. Planning and working on this foundation needs to be calculated correctly to avoid any decline or even collapse of the building. Therefore, researchers will discuss the Design of Pile Foundations in the SMP Mitra Kasih Banjarmasin Building.

2. THEORITICAL STUDY

2.1. Pancang Pile Foundation

Pile foundations are used to support buildings when strong soil layers are located very deep. Pile foundations are used to support buildings that resist upward lifting forces, especially in high-rise buildings which are affected by overturning forces due to wind loads. Heap establishments are utilized for a few purposes, including:

1. To send the heap of structures situated on water or delicate soil areas of strength for to soil.
2. To communicate the heap to generally delicate soil to a specific profundity so the structure establishment can offer adequate help to help the heap by the grinding of the side of the heap with the encompassing soil.

At this time has been widely used various types of deep foundations. Use is adjusted to the magnitude of the load, environmental conditions, and soil layers. The pile classification based on the method of implementation is as follows:

1. Driven pile: the pile is installed by making a circular or elongated square material which is printed first and then driven or pressed into the ground.
2. Drilled shaft: the pile is installed by first drilling the ground to a certain depth, then steel reinforcement is inserted into the drilled hole and then filled/casted with concrete.

Judging from the way it supports the load, the pole is divided into 2 types,

namely:

1. End bearing pile

   In general, the end supports are in the zone of soft soil underlain by hard soil. Piles are driven so that they reach bedrock or hard layers so that they can support the load without causing excessive settlement.

2. Friction Pile

   Grinding heaps are heaps whose bearing limit is resolved more by the frictional obstruction between the sides of the heap and the encompassing soil. The frictional opposition and the impact of combination of the basic layers are considered in the computation of the heap bearing limit.

2.2. Support Capacity

The ability of the soil to support the foundation load of the structure above it is the subject of bearing capacity analysis. Bearing capacity refers to the soil's ability to exert shear resistance along its shear planes in order to resist settlement caused by loading.

Establishment configuration should think about the presence of shear disappointment and exorbitant settlement. Therefore, it is important to satisfy two measures, to be specific: strength standards and decrease rules.

The necessities that should be met in the plan of the establishment are:

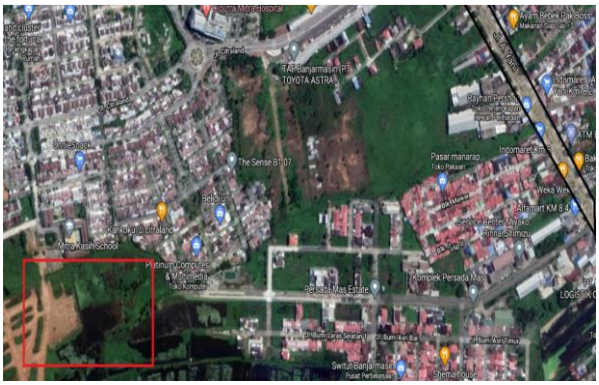
1. The security factor against breakdown because of surpassing the dirt bearing limit should be met. In working out the bearing limit, the element of wellbeing is for the most part utilized.
2. The settlement of the establishment should be inside the constraints of the mediocre worth. Specifically, differential settlement should not bring about harm to the design.

3. METHOD

3.1 Research Locations

This research was conducted at Mitra Kasih Citraland Middle School Building located on Jl. A. Yani Km. 7.8 Banjarmasin, South Kalimantan and located between

the Mitra Kasih Elementary School and Mitra Kasih High School buildings can be seen in Figure 1.



Picture 1. Research Sites

3.2 Preparation Stage

The preparatory stage that was carried out before starting the design was to collect library sources that would be used in the work on this final project, in the form of applicable regulations, journals, or books. The guidelines utilized incorporate SNI 1727-2020 concerning least plan stacks and related measures for structures and different designs, SNI 8640-2017 concerning geotechnical plan necessities. PPPURG 1987, and SNI 1726-2019 concerting primary substantial prerequisites for structures.. Likewise, a field review was likewise done at the area to be planned.

3.3 Data Collection

Data collection aims to obtain important data needed in the design. The data obtained are:

1. Land data in the form of N-SPT and sondir data conducted by PT Geo Inti Perkasa.
2. Building plans drawn by Detail Studio.

4. RESULTS AND DISCUSSION

4.1. Preliminary Design and Burden

The design of the fondation requires the calculations of the superstructure, which is carried out to determine the forces that occur in the superstructure and which will be supported by the substructure. The calculation will be carried out

using the ETABS v.18 software by calculating the dead load, live load, earthquake load, and wind load then from these loads a combination of loads will be carried out. Structural modeling will be carried out in three dimensions with ETABS software. The building data is:

Location : Banjarmasin
Building Function : School
Number of Floors : 4 floors
Type of Land : Soft soil
Building Height : 16,75 m

4.2. Calculation of Building Structure Loading

Table 4.5 Overall Load Table

Total Beban (kN)							
	Dead Load	Live Load	Wall	Beam	Column	Slab	total
GF Floor	8696,20	3303,18	8320,00	1591,13	1597,61	260832	284340,12
2nd Floor	9779,48	2909,10	8918,40	2765,95	819,24	260832	286024,17
3rd Floor	9597,08	2272,74	8736,00	2765,95	819,24	260832	285023,01
4th Floor	6849,16	2981,32	5988,08	2765,95	204,26	260832	279620,77
Rooftop	1539,95	1966,88	678,87	1174,97	236,66	84648	90245,32
Total Load (kN)							1225253,38

Then based on the structural analysis is done by inputting the building model as well as loading and loading combinations using ETABS software. The results of the structural analysis can be seen in the following table:

Table 4.10 Results of Joint Structure Analysis

No. prltkn	Label		FX	FY	FZ	MX	MY	MZ
			ton	ton	ton	ton-m	ton-m	ton-m
744	I	1	19,22	-14,66	197,55	-2,90	2,97	-0,15
759		2	-23,10	-23,78	221,71	3,83	-7,45	-0,34
761		3	27,49	-22,45	237,99	4,34	9,15	0,25
772		4	-21,42	-17,34	197,99	7,57	1,09	-0,24
707	G	1	43,39	3,47	300,44	-3,28	13,55	-0,10
683		2	-35,61	1,55	385,36	0,78	-12,58	-0,08
685		3	40,37	-0,11	398,57	2,36	13,37	-0,07
715		4	-49,79	1,19	306,04	6,00	-16,36	-0,07

705	F	1	34,39	14,25	211,00	-3,46	9,95	-0,12
669		2	-31,58	20,68	237,29	-0,76	-11,74	-0,05
673		3	33,09	21,42	230,46	0,66	10,47	-0,10
713		4	-39,84	14,96	205,67	5,40	-13,45	-0,06
703	E	1	37,16	-17,25	223,79	0,59	10,58	-0,07
667		2	-33,19	-23,46	242,77	4,84	-12,55	-0,10
671		3	32,71	-20,18	238,37	5,79	10,08	-0,06
711		4	-39,58	-15,58	222,32	9,20	-13,62	-0,13
701		1	52,75	-1,17	300,98	0,45	15,41	-0,03
667	D	2	-33,19	-23,46	242,77	4,84	-12,55	-0,10
661		3	34,67	7,25	311,73	1,98	10,20	-0,07
709		4	-42,01	4,84	284,49	7,70	-15,19	-0,18
732	B	1	18,43	16,39	201,95	-0,57	-11,80	-0,19
651		2	-20,09	22,41	229,93	1,44	-8,31	0,12
653		3	14,69	21,06	240,10	2,53	4,31	0,32
736		4	-6,11	3,16	171,20	8,45	-8,87	-0,25

4.3 Calculation of Pile Strength

- Land Data

TEST RESULT DATA			LABORATORY (SOIL DRILLING DATA)				SONDIR	SPT
No	Depth		Type Land	c_u (kN/m²)	γ (kN/m³)	φ (... ▫)	q_f (kN/m²)	Nilai SPT N
	z_1 (m)	z_2 (m)						
1	0,00	5,00	Clay	25,00	17	30	9,00	8
2	5,00	10,00	Clay	50,00	19	35	46,00	14
3	10,00	20,00	Clay	100,00	19	35	46,00	30
4	20,00	30,00	lemp. silt	200,00	19	40	91,00	44
5	30,00	35,00	Solid Sand	0,00	19	45	274,00	50

- Material Data

  Type of Pile = Spun Pile

  Pile Diameter, D = 500 mm = 0.5 m Pile Length, L = 35 m

  Compressive Strength of Concrete Pile, K-500 or fc' = 41.5 MPa Weight of Reinforced Concrete, wc = 24 kN/m³.Rekap Tahanan Aksial Tiang Pancang

- Pancang Recap of the Axial Resistance of Piles

No	Description of the Axial Resistance of Piles	ϕP_n
	Based on the strength of the material	898,65
	Based on drill data (Skempton)	912,23

Based on sondir test results (Bagemann)			3452,61
Based on SPT test results (Meyerhoff)			885,93
The smallest axial bearing capacity,		$\phi * P_n =$	885,93
Take the axial resistance of the pile,	→	$\phi * P_n =$	880,00

- Calculation of Foundation Strength (PC5)

The arrangement of the piles in the x direction:				he arrangement of the piles in the y direction:			
No.	Amount n	x (m)	$n * x^2$ (m^2)	No.	Amount n	y (m)	$n * y^2$ (m^2)
1	2	1,25	3,13	1	2	1,25	3,13
2	1	0,00	0,00	2	1	0,00	0,00
3	2	-1,25	3,13	3	2	-1,25	3,13
n =	5	$\Sigma x^2 =$	6,25	n =	5	$\Sigma y^2 =$	6,25
The width of the x-direction pilecap,						$L_x =$	3,75
The width of the y-direction pilecap,						$L_y =$	3,75

- Calculation of Foundation Strength (PC6)

The arrangement of the piles in the x direction:				The arrangement of the piles in the y direction:			
No.	Amount n	x (m)	$n * x^2$ (m^2)	No.	Amount N	y (m)	$n * y^2$ (m^2)
1	2	1,25	3,13	1	3	0,63	1,17
2	2	0,00	0,00	2	3	-0,63	1,17
3	2	-1,25	3,13				
n =	6	$\Sigma x^2 =$	6,25	n =	6	$\Sigma y^2 =$	2,34
The width of the x-direction pilecap,						$L_x =$	3,75
The width of the y-direction pilecap,						$L_y =$	2,50

- Calculation of Foundation Strength (PC7)

The arrangement of the piles in the x direction:				The arrangement of the piles in the y direction:			
No.	Amount n	x (m)	$n * x^2$ (m^2)	No.	Amount n	y (m)	$n * y^2$ (m^2)
1	2	1,25	3,13	1	3	1,25	4,69
2	3	0,00	0,00	2	1	0,00	0,00
3	2	-1,25	3,13	3	3	-1,25	4,69
n =	7	$\Sigma x^2 =$	6,25	n =	7	$\Sigma y^2 =$	9,38
The width of the x-direction pilecap,						$L_x =$	3,75
The width of the y-direction pilecap,						$L_y =$	3,75

- Calculation of the Cost Budget Plan

  From the quantity calculation above, the budget plan for the building planning is obtained.

Table 4.16 List of Quantity and Price

DAFTAR KUANTITAS DAN HARGA
SPESIFIKASI 2021

Proyek / Bagpro : Proyek Pembangunan Sekolah Mitra Kasih Ciputra
Nama Paket : Pembangunan Sekolah Mitra Kasih Ciputra
Prop / Kab / Kodya : Kalimantan Selatan

No. Mata Pembayaran	Uraian	Satuan	Perkiraan Kuantitas	Harga Satuan (Rupiah)	Jumlah Harga-Harga (Rupiah)
a	b	c	d	e	f = (d x e)
	DIVISI 3. PEKERJAAN TANAH DAN GEOSINTETIK				
3,1	Galian struktur 0,00 s.d -1,25 m	Meter Kubik	375,00	68.262,00	25.598.250,00
3.2	Timbunan	Meter Kubik	150,00	117.480,00	17.622.000,00
	Jumlah Harga Pekerjaan DIVISI 3 ***(masuk pada Rekapitulasi Perkiraan Harga Pekerjaan)***				**43.220.250,00**
	DIVISI 7. STRUKTUR				
7.1 (3)	Beton mutu sedang fc' 25 MPa	Meter Kubik	225,00	1.754.158,00	394.685.550,00
7.3 (2)	Baja Tulangan Ulir 400 Mpa	Kilogram	11.870,40	18.801,00	223.175.449,09
7.4 (1)	Baja Tulangan Polos 240 Mpa	Kilogram	354,26	17.897,00	6.340.235,62
7.6.(1)	Penyediaan Tiang Pancang Spun Pile D500 mm (Panjang 35 meter)	Meter	5.040,00	564.225,00	2.843.694.000,00
7.6.(2)	Pemancangan Tiang Pancang Spun Pile D500 mm (Panjang 35 meter)	Meter	5.040,00	341.974,00	1.723.548.960,00
	Jumlah Harga Pekerjaan DIVISI 7 ***(masuk pada Rekapitulasi Perkiraan Harga Pekerjaan)***				**5.191.444.194,72**

Table 4.17 Budget Plan Recapitulation

REKAPITULASI
PERKIRAAN HARGA PEKERJAAN

Proyek / Bagpro : Proyek Pembangunan Sekolah Mitra Kasih Ciputra
Nama Paket : Pembangunan Sekolah Mitra Kasih Ciputra
Prop / Kab / Kodya : Kalimantan Selatan

No. Divisi	Uraian	Jumlah Harga Pekerjaan (Rupiah)
1	Umum	-
2	Drainase	-
3	Pekerjaan Tanah dan Geosintetik	43.220.250,00
4	Pekerjaan Preventif	-
5	Pekerasan Berbutir dan Perkerasan Beton Semen	-
7	Struktur	5.191.444.194,72
9	Pekerjaan Harian dan Pekerjaan Lain-Lain	-
10	Pekerjaan Pemeliharaan Kinerja	-
(A) Jumlah Harga Pekerjaan (*termasuk Biaya Umum dan Keuntungan*)		**5.234.664.444,72**
(B) Pajak Pertambahan Nilai (PPN) = 10% x (A)		**523.466.444,47**
(C) JUMLAH TOTAL HARGA PEKERJAAN = (A) + (B)		**5.758.130.889,19**
(D) Dibulatkan		**5.758.130.889,00**

Terbilang : ***5 Milyard Tujuh Ratus Lima Puluh Delapan Juta Seratus Tiga Puluh Ribu Delapan Ratus Delapan Puluh Sembilan Rupiah***

5. CONCLUSION

From this research it can be concluded that:

1. According to the results of structural analysis calculations, foundations are divided into 3 types:
2. Piling Data

   PC5 foundation with factored load column axial force Pux = 2380.76 kN

   PC6 foundation with factored load column axial force Pux = 3057.03 kN

   PC7 foundation with factored load column axial force Pux = 3908.64 kN

Table 5.1 Pile Data

PC5 type foundation	PC6 type foundation	PC7 type foundation
Pile axial resistance = 880 kN Pile lateral resistance = 59,46 kN The width of the pile cap in the x direction = 3,75 m The width of the pile cap in the y direction = 3,75 m Pile cap thickness = 0,75 m Pile cap reinforcement = x direction bending: D19-150 y direction bending: D19-150 Shrink in the x direction : Ø13 – 120 Shrink in the y direction : Ø13 – 120 Pole dimensions = Spun pile Ø500 mm long 35 m Pole depth = 35 m Number of poles = 5 poles Number of pile caps = 8 pieces (40 poles)	Pile axial resistance = 880 kN Pile lateral resistance = 59,46 kN The width of the pile cap in the x direction = 3,75 m The width of the pile cap in the y direction = 2,5 m Pile cap thickness = 0,75 m Pile cap reinforcement = x direction bending: D19-100 y direction bending: D19-150 Shrink in the x direction: Ø13 – 120 Shrink in the y direction: Ø13 – 120 Pole dimensions = Spun pile Ø500 mm long 35 m Pole depth = 35 m Number of poles = 6 tiang Number of pile caps = 8 pieces (48 poles)	Pile axial resistance = 880 kN Pile lateral resistance = 59,46 kN The width of the pile cap in the x direction = 3,75 m The width of the pile cap in the y direction = 3,75 m Pile cap thickness = 0,75 m Pile cap reinforcement = x direction bending:: D19-90 y direction bending: D19-100 Shrink in the x direction : Ø13 – 120 Shrink in the x direction: Ø13 – 120 Pole dimensions = Spun pile Ø500 mm long 35 m Kedalaman Pole depth = 35 m Number of poles = 7 tiang Number of pile caps = 8 pieces (56 poles)

3. Cost budget plan

   Earthwork and Geosynthetic = Rp. 43.220.250,00

   Structure = Rp. 5.191.444.194,72

   Total price of work = Rp. 5.234.664.444,72

   Value Added Tax (10%) = Rp. 523.466.444,47

   TOTAL JOB = Rp. 5.758.130.889,00

In words: Five Billion Seven Hundred Fifty Eight Million One Hundred Thirty Thousand Eight Hundred Eighty Nine Rupiah.

REFERENCES

Badan Standarisasi Nasional. 2019. *SNI 1726: 2019 Tata Cara Perencanaan Ketahanan Gempa Untuk Struktur Bangunan Gedung dan Non Gedung.* Jakarta: Badan Standardisasi Nasional.

Badan Standarisasi Nasional. 2020. *SNI 1727: 2020 Beban Minimum Untuk Perancangan Bangunan Gedung dan Struktur Lain*. Jakarta: Badan Standardisasi Nasional.

Badan Standarisasi Nasional. 2020. *SNI 8640: 2017 Persyaratan perancangan geoteknik*. Jakarta: Badan Standardisasi Nasional.

Departemen Pekerjaan Umum. 1987. *Perancangan Perencanaan Pembebanan Untuk Rumah dan Gedung.* Jakarta: Yayasan Badan Penerbit Pekerjaan Umum.

Geo Inti Perkasa. 2018. *Pekerjaan Penyelidikan Tanah untuk Rencana Pembangunan Sekolah Mitra Kasih Di Citra Land Banjarmasin Prov. Kalimantan Selatan.* Banjarmasin: PT Geo Inti Perkasa.

Lestari, Aulia Ayu. 2021. *Perancangan Fondasi Tiang Pancang Bangunan Bertingkat Sepuluh: Pengembangan Gedung Dinas Komunikasi Dan Informatika Kabupaten Tapin. Banjarmasin:* Tugas Akhir Program Sarjana Strata Satu (S1) Teknik Sipil Universitas Lambung Mangkurat.