CERUCUK
Volume 9 No. 4 2025 (176-185)

EVALUATION OF CONCRETE CONSTRUCTION COLLAPSE ON THE MARTAPURA RIVERBANK AND SAFE DESIGN

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ABSTRACT

The footbridge in Gang Gusti Galuh is a construction built for the needs of local pedestrian traffic, over time the footbridge collapsed. The collapse of the Concrete Footbridge Construction in Gang Gusti Galuh in early 2024 between January-February has added to the series of concrete construction failures in Indonesia, especially in South Kalimantan.
The collapse of this bridge was due to inadequate foundation support and the influence of inhomogeneous soil. The purpose of this design is to determine the cause of the collapse and analyze what forces occur in the construction and its new design that is safe to use. The results of this evaluation indicate that the existing condition of the bridge with a wooden foundation is not safe to use and will be replaced with a new foundation using concrete piles to be more adequate and safe to use.

Keywords: Construction, Footbridge, Redesign

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1. INTRODUCTION

Economic growth in a region is influenced by its transportation facilities. Transportation facilities in the form of good roads, strong bridges, and other facilities will be adequate for various community activities and facilitate access for pedestrians and some motorcyclists in Gang Gusti Galuh, Jl. Panglima Batur RT.6 RW.1 Kel. Surgi Mufti District, North Banjarmasin, Banjarmasin City, Martapura Riverbank, Jingah River Area.

The concrete bridge in Gang Gusti Galuh is a construction built for the needs of local pedestrian traffic, over time the bridge collapsed. The collapse of the Concrete Bridge Construction in Gang Gusti Galuh in early 2024 has added to the series of concrete construction failures in Indonesia, especially in South Kalimantan. The collapse of this concrete bridge has hampered road access for local residents and forced them to find another way.

According to local residents, a review of the collapse of the concrete footbridge in Gang Gusti Galuh was carried out so that the cause of the collapse of this concrete footbridge was because many of the poles were rotten and the distance between the poles was too fragile, plus there were heavy rains and strong winds which made the river flow heavy and the poles became worse. decreased by the soil

Figure 1.1 Condition of the Bridge Collapse In order to evaluate this footbridge, the work process carried out in this project is to replace the footbridge which still uses a wooden foundation with a pile foundation to improve safety and permanent transportation for the local community.

2. THEORETICAL BASIS

Understanding of Footbridge Planning

A bridge or footbridge is a building construction that aims to connect one road to another road through an obstacle that is lower than the surface of the footbridge, be it a river, lake, valley or other (Surpiyadi and Muntohar, 2007).

Loading On Bridge

The planned bridge structure, its strength to withstand the loads that occur and its combination are calculated based on the Bridge Load Planning Standard SNI 1725:2016.

Actions (displacement loads and other influences) are grouped into several groups, namely permanent actions, traffic loads, environmental actions and others.

Floor Plates

The plate is a structural plane that has a thickness that tends to be much smaller compared to the dimensions of other structural components. The geometry in the plate is usually limited by straight or curved lines. In the planning of this bridge, a reinforced concrete plate is used as the floor. The floor in question is the middle part of the bridge plate as wide as the traffic lane which is used to directly receive traffic loads.

Beam

(Asroni, 2010) Concrete beams are one of the portal construction elements with a horizontal span. Reinforced concrete beams are structural components made of composite materials that combine concrete and steel reinforcement into a single structural unit. The shear strength of concrete beams can be increased by installing shear reinforcement (Seiawan, 2016).

Pile Foundation

The foundation is a structural part that connects a building to the ground. The foundation must also ensure the stability of the building structure itself, its capacity to withstand loads and resistance to external forces such as wind pressure and earthquakes. (Heinz Frick et al., 1998). The pile foundation functions to transfer the construction load above it to the hard soil layer at a fairly deep depth (Ramadhani et al., 2021)

Bearing Capacity of Pile

The ability of the foundation to carry the load is an important aspect in planning, but after the foundation is installed in the field, a pile capacity analysis is needed to determine its actual capacity. The pile capacity can be calculated with data at the time of pile driving, namely with calendaring data used in pile driving work, namely to determine the bearing capacity of the pile through the calculations produced.

3. METHOD

The location of this planning is on Jl. Panglima Batur Gg. Gusti Galuh RT.6 RW.01 Kel. Surgi Mufti Kec. North Banjarmasin Banjarmasin City (3˚18'31.4"LS 114˚ 35'43.8'BT). The data used in this planning is soil investigation data in the form of sondir data and field surveys. Furthermore, an evaluation is carried out between the existing bridge design and the new bridge design by calculating and modeling using the SAP2000

application starting from the preliminary design for loading the existing structure and the new structure, calculations are made for the floor slabs and beams used on the bridge, after which the distribution calculation is carried out on the strength of the piles using the Meyerhoff method to analyze the wooden foundation and several methods such as the Broms method, Brinch Hansen to analyze the pile foundation. Calculation of the axial and lateral pile bearing capacity to determine its bearing capacity whether it is able to withstand the load used and the pile settlement is carried out to determine how long the settlement occurs in the foundation.

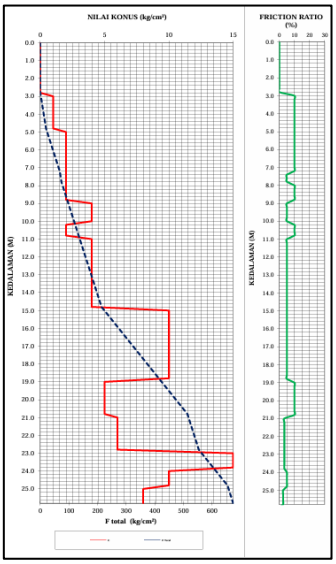
4. RESULTS AND DISCUSSION

In the planning of road improvement on Jl. Panglima Batur Gg. Gusti Galuh RT.6 RW. 1 Kel. Surgi Mufti Kec. North Banjarmasin Banjarmasin City Planning for the Replacement of Footbridge Construction, an evaluation of the collapse of the footbridge was carried out by analyzing the cause of the collapse and then replaced with a new construction so that it is safe to use.

Land Data Interpretation

	Kedalaman	qc (kg/cm2)	fr	Jenis Tanah	Konsistensi	γ (gr/cm3)	Cu (kg/cm2)	Ø ( )°
SONDIR S-1	0,0 - 2,8	0	0	Lempung	Sangat Lunak	1.600	0	30.500
	3,0 - 4,8	1	10	Lempung	Sangat Lunak		0.05	
	5,0 - 8,8	2	10	Lempung	Sangat Lunak		0.1	
	9,0 - 10,0	4	5	Lempung	Sangat Lunak		0.2	
	10,2 - 10,8	2	20	Lempung	Sangat Lunak		0.1	
	11,0 - 14,8	4	5	Lempung	Sangat Lunak		0.2	
	15,0 - 18,8	10	5	Lempung	Sangat Lunak		0.5	
	19,0 - 20,8	5	10	Lempung	Sangat Lunak		0.25	
	21,0 - 22,8	6	3.33	Lanau Berlempung	Lunak		0.3	
	23,0 - 23,8	15	3.3	Lanau Berlempung	Lunak		0.75	
	24,0 - 24,8	10	5	Lempung	Sangat Lunak		0.5	
	25,0 - 25,8	8	2.5	Lanau Berlempung	Lunak		0.4	

	Kedalaman	qc (kg/cm2)	fr	Jenis Tanah	Konsistensi	γ (gr/cm3)	Cu (kg/cm2)	Ø ( )°
SONDIR S-2	0,0	0	0	Lempung	Sangat Lunak	1.600	0	30.500
	0,2-0,4	6	3.33	Lempung	Sangat Lunak		0.3	
	0,6-0,8	4	5	Lempung	Sangat Lunak		0.2	
	1,0-2,8	1	10	Lempug	Sangat Lunak		0.05	
	3,0-6,8	2	10	Lempung	Sangat Luak		0.1	
	7,0-7,8	1	10	Lempung	Sangat Lunak		0.05	
	8,0-11,8	2	10	Lempung	Sangat Lunak		0.1	
	12,0-12,8	3	6.67	Lempung	Sangat Lunak		0.15	
	13,0-17,8	4	5	Lanau Berlempung	Lunak		0.2	
	18,0-19,8	5	4	Lanau Berlempung	Lunak		0.25	
	20,0-20,2	10	2	Lempung	Sangat Lunak		0.5	
	20,4-20,8	8	2.5	Lanau Berlempung	Lunak		0.4	
	21,0-22,8	5	6	Lanau Berlempung	Lunak		0.25	
	23,0-23,8	15	3.33	Lanau Berlempung	Lunak		0.75	
	24,0-26,8	10	5	Lanau Berlempung	Lunak		0.5	



Existing Carrying Capacity Calculation

For the calculation of the bearing capacity of the piles, data from the results of soil investigations carried out at the planned location were used. In its implementation, pile group foundations were used and using piles made of galam wood with an average depth of 7 meters and a tip diameter of 10 cm. The calculation of the bearing capacity of the pile foundation using the Meyerhoff Method obtained the following results:

for the friction load bearing capacity of the pile is:

$$Qa2 = \frac{JHP \times U}{Fk_2}$$

$$= \frac{32 \times 21{,}98}{5}$$

= 140.672 kg

= 0.14 tons

for the permitted bearing capacity of one pile foundation is:

Qa = Qa_1 + Qa2

= 0.02 + 0.14

= 0.16 tons

So, the permit capacity obtained for one galam wooden pole is 0.30 tons.

In this foundation, 15 pillars are used with the following arrangement:

m (number of rows of poles) = 5

n (number of poles in a row) = 3

for the bearing capacity of the pile group is:

Qg = m . n .Qa

= 5 . 3 . 0.16

= 2.4 tons

Pu = 3.1 tons >Qg = 2.4 tons < Not Safe.

From the results of the analysis, the cause of the collapse was due to foundation failure due to inadequate foundation bearing capacity, limited pile material in supporting quite large loads, the influence of inhomogeneous soil and unsupportive soil layer conditions.

Foundation Design Capacity

No	Description of Axial Resistance of Piles	ϕ . Pn
1	Based on material strength	293.40
2	Based on soil drill data (Skempton)	104.55
3	Based on the results of the sounding test (Bagemann)	84.70

The smallest axial bearing capacity is as follows:

ϕ . Pn =84.70 kN

Due to safety factors in structural design, a more conservative axial resistance value is taken, namely:

The axial resistance of the pile is taken as follows:

ϕ . Pn =80.00 kN

Based on the calculation results of the axial bearing capacity of piles with various methods, it is concluded that the safe and acceptable axial bearing capacity value of this

pile foundation is 80.00 kN. This value is the smallest axial capacity taken to ensure that the pile foundation can withstand the applied load without exceeding its bearing capacity.

No	Description of Pile Lateral Resistance	f * Hn
1	Based on maximum pole deflection	18.49
2	Based on maximum moment	27.71

The smallest lateral resistance of the pile, f * Hn = 18.49 kN

The lateral resistance of the pile is taken, → f * Hn = 10.00 kN

Overall, these calculations show that the planned piles can have sufficient lateral resistance with a resistance value of 10.00 kN after considering the strength reduction factors in both approaches.

Land Bearing Capacity

$$Q_{izin} = \frac{qc \times Ac}{SF1} \times \frac{JHP \times Kl}{SF2}$$

$$= \frac{20 \times 625}{3} + \frac{840 \times 100}{7}$$

$$= 16{,}17\ ton$$

a) Determining the Number of Piles (n), Estimating the Number of Piles (n)

$$n = \frac{P_u}{Q_{izin}}$$

$$= \frac{10{,}02}{16{,}17}$$

$$= 0{,}62 \approx 1\ buah$$

Distance Between Poles (S1)

$$S1 = 2{,}5D \leq S1 \leq 4D$$

$$= 2{,}5 \times 250 \leq S1 \leq 4 \times 250$$

$$= 625\ mm \leq S1 \leq 1000\ mm$$

Elastic Deterioration In Poles

Single Pole Drop:

$$S = \frac{Diameter}{100} + \frac{Beban\ untuk\ 1\ tiang\ x\ L}{Ab\ x\ Eb}$$

$$S = \frac{0{,}25}{100} + \frac{3{,}44\ x\ 30}{0{,}0625\ x\ 309131{,}33}$$

$$S = 0{,}0078414\ m = 0{,}7841419\ cm$$

From the calculation of the mini pile settlement, the total settlement is 0.8 cm. After calculating the mini pile settlement, the next step is to calculate the settlement time to reach total settlement with the following formula:

$$t = \frac{T\ x\ Hdr^2}{Cv}$$

With,

t : Timeconsolidation (year)

T :Consolidation time factor (T95 = 1.163)

Hdr : Longfoundation (cm)

Cv :Consolidation coefficient(cm^2/s)

So that,

$$t = \frac{T\ x\ Hdr^2}{Cv}$$

$$t = \frac{1{,}163\ x\ 3000^2}{0{,}0009}$$

$t95\% = 11630000000$second

$t95\% = 373{,}91$year

So to achieve a total decline of 0.0078 meters it takes 373.9 years. Next, a calculation is made for the total decline permitted based on SNI 8460-2017.

Total allowable decrease:

$$S_{izin} = < 15\ cm + b/600$$

With,

b = foundation dimension = 0.25 m = 25 cm

$b/600$ = 0.04 cm

$S_{izin} = < 15{,}04$

So that the total permitted decrease is obtained, namely,

$0{,}0078 = S_t < S_{izin} = 15{,}04$ **(SAFE)**

If it is determined that the foundation with mini piles will operate for 10 years, then the prediction for the magnitude of the derivative that will occur is calculated as follows:

$t_{10\ tahun} = 311040000$second

Cv =$0{,}0009\ cm^2/s$

Hdr = 3000 cm

$$T = \frac{t\ x\ Cv}{Hdr^2}$$

$$T = \frac{311040000\ x\ 0{,}0009}{3000^2}$$

$$T = 0{,}0311$$

$$\mathrm{U} = 100 - (\frac{1{,}781 - T}{0{,}933})^{10}$$

$$\mathrm{U} = 100 - (\frac{1{,}781 - 0{,}0311}{0{,}933})^{10}$$

$$\mathrm{U} = 24{,}91\%$$

$$S_{2034} = \frac{total\ penurunan\ x\ U}{100}$$

$$S_{2034} = \frac{0{,}8\ x\ 24{,}9}{100}$$

$$S_{2034} = 0{,}1954\ m$$

$$S_{2034} = 19{,}536\ cm$$

So the predicted amount of decline in 2034 is 19,536 cm.

Figure 1.4 Condition of the New Bridge

Analysis of Bridge Location Against Erosion and Scouring

Based on observations at the planned location of this bridge, this area has not experienced any erosion or scour because the collapse of the previous bridge foundation was caused by construction errors or reduced material quality and inadequate foundation support capacity and in particular South Kalimantan is not an earthquake-prone area and its river flow is not too fast.

5. CONCLUSION

The cause of the collapse of this bridge was due to the failure of the foundation due to inadequate foundation bearing capacity, limited pile material in supporting a fairly large load, the influence of inhomogeneous soil and unsupportive soil layer conditions and the results of the new design analysis used on this bridge were to replace the structure with concrete and the foundation which initially used wood became piles. The piles used were 25x25 cm minipiles which were clearly safe to use to anticipate the collapse that

occurred. And it has also been obtained with new design calculations that this new design design is safe to be designed on this bridge.

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