Analysis Counterfort Retaining Walls On Mempura River Cliff for Historic Site Security On Mempura River Village

by Zainuri Z

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Analysis Counterfort Retaining Walls On Mempura River Cliff for Historic Site Security On Mempura River Village

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Abstract

Historic sites located in the village of Mempura River are the tomb of a relative Siak kingdom named Tengku Buang Asmara, not far from the Mempura river's cliff across village of Mempura River. Conditions unspoiled river bank and eroded continuously. Therefore, they need a cliff's security wall to maintain the existence of historic sites. But the problem is, whether cliff's safety wall counterfort are technically suitable for use in the Mempura River's cliff walls. The purpose of this research was to analyze the stability of a retaining wall on the riverbank cliff types counterfort Mempura River in the vicinity of the historic sites that still exist today. This research was conducted over nine months, starting in September 2014 until May 2015. The research location is in the village of Mempura River, district Mempura, Siak regency, Riau Province. Location research narrowed to the area around the historic sites on the edge of the Mempura River. The calculation result shows that the security wall climbing dimension counterfort height of 3 m; slab width of 1,5 m; thick concrete plate 0,2 m; the width of the side walls 2,97 m; obtained value of the safety factor against rolling by 7,39; the value of the safety factor against sliding 3,76; eccentricity value of -0,17; the value of the soil bearing capacity for q_1 = 5003,61 kg/m^2 and q_2 = 953,07 kg/m^2.All criteria and values are met by a wall of cliffs safety counterfort thus concluded that this type of appropriate and recommended for safety Mempura river cliff.

Keywords: counterfort; cliff's safety wall

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INTRODUCTION

Historic sites located in Sungai Mempura be the tomb of a relative Siak Kingdom namely Tengku Buang Asmara. The area is not far from the grave of a Mempura river's cliff that crosses the village of Mempura River. Condition pristine river canyon and eroded continuously. If this problem continue, the historic site will be lost, eroded or lost follow overgrown because there is no treatment. Besides aiming to protect historical district, is also aimed at structuring the tourist area, the presence of the river canyon can be maintained by building a security wall climbing.

There are several types or models of a safety wall of the riverbank that can be made to maintain the existence of the historical district in question. One is the security wall climbing counterfort. Benefits using counterfort models wall climbing safety is more efficient in material usage compared to other models. But the problem is, whether the security wall climbing counterfort are technically suitable for use in the cliff wall Mempura River?

The research located on Mempura River Village, District Mempura, Siak District, Riau Province. Location studies narrowed to the area around the historic sites located on the banks Mempura. Exam-med cliff length 50 meters, on the side adjacent to the historic sites. The

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research was conducted on the ground in a laboratory examination at the location, and some other activities that take at every stage.

According to the PP 35/1991 about river, the river in general are places and containers also water drainage networks began to spring to the estuary which restricted the right and left and up streaming along the demarcation line. River according to its part divided into 3 parts, upstream, middle-stream and downstream, each has a different cross-section and physical character. The cross-section of the river flow is divided into two parts, inner river (instream) and the outer part of the river (outstream).

Changes in the river flow's form caused damage to inner river (instream), the type of damage to water bodies, among others: 1) Erosion of riverbanks/ abrasion, 2) A gradation and degradation, 3) Local scouring, 4) Avalanche/ subsidence (sliding).

Soil is the support foundation for a building and can be used as material of construction of the building itself like a levee or dam. Classification and properties of the soil supporting the foundation to estimate the strength of the foundation.

Active soil pressure refers to a plastic equilibrium was pictured on the rupture circle. The maximum and minimum power can be used to calculate the pressure is on (in Bowles, 1986). The difference between the maximum and minimum power equal to deviator stress which has a sliding line. In the key areas there is pressure. The minimum primary pressure is also called active soil pressure and can be calculated using the formula:

$$\sigma 3 = (q + \gamma h) \tan^2\left(45 - \frac{\phi}{2}\right) - 2c \tan^2\left(45 - \frac{\phi}{2}\right) \quad \ldots\ldots (1)$$

Land will be deformed, but because it was rejected by the surrounding soil, the pressure that can affect deformation must be larger than the comparison of the following equation:

$$\sigma 1 = \gamma h \tan^2\left(45 + \frac{\phi}{2}\right) + 2c \tan^2\left(45 + \frac{\phi}{2}\right) \quad \ldots\ldots (2)$$

Information:

σ3	= active ground pressure (t/m2)
q	= burden to be detained (t/m2)
γ	= heavy volume of underwater soil(t/m3)
h	= distance from ground level (m)
c	= soil cohesion (t/m2)
ø	= angle of friction for the soil (o)

The equation used is based on the theory Rankine cohesing land for active and passive wall style are:

$$Pa = 0{,}5\gamma H^2 Ka - 2.c.\sqrt{Ka} \qquad Pp = 0{,}5\gamma H^2 Kp + 2.c.\sqrt{Kp} \quad \ldots\ldots (3)$$

$$Ka = \tan^2\left(45 - \frac{\phi}{2}\right) \qquad Kp = \tan^2\left(45 + \frac{\phi}{2}\right) \quad \ldots\ldots (4)$$

Information:

Pa	= active ground pressure (t/m2)
Pp	= passive earth pressure (t/m2)
γ	= heavy volume of underwater soil (t/m3)
H	= distance from ground level (m)
Ka	= coefficient of active soil
Kp	= coefficient of passive soil
ø	= angle of friction for the soil (o)

According to Das, B.M (2005) in general there are four kinds of security wall climbing, namely: 1) Wall gravity seat, 2) Wall semi gravity seat, 3) Wall cantilever seat4) Wall counter fort seat. The stability of the security walls climbing counterfort, stability of the bolster; formula used is:

$$Fg = \Sigma Mt / \Sigma Mg \quad \ldots\ldots (5)$$

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Information:
Mt = Moment of resistance (ton.m)
Mg = Moment bolsters (ton.m)
Fg = Factor bolsters security

The minimum safety factor value can be seen in the following table.

Table 1: The Values of Minimum Safety Factor

Building Type	FK
Building Type: Wall Excavation reinforced provisional (temporary retaining wall)	 3,0 2,0
Bridges : Aqueducts Train Highway	 3,0 4,0 3,5
Building : Operation tower, Silo Warehouse Building facilities Small industry, public	 2,5 2,5* 3,0 3,5
Palms foundation	3,0
Mat foundation	3,0
* Modern warehouse with floor plates typically have broad to accommodate modern transportation equipment. This floor needs to be designed with strict conditions on reductions in total and differential decrease with FK> 3	

Stability against sliding; the formula used to find the ratio of shearing resistance force against the force that causes the occurrence of sliding is:
$Fs = (\Sigma W.\ M) / PH$ .... (6)
Information:
Fs = shear safety factor
W = vertical force (tons)
μ = coefficient of sliding pads
PH = Style hirozontal (tons)

Table 2: The Coefficient of Sliding Between Construction and Its Base

Material	Coeffisient (μ)
Compact, irregular rocks	0,80
Slightly fissured rock	0,70
Coral and coarse sand	0,40
Sand	0,30
Coarse grained clay	0,50 - 0,55
Mud needs investigation in the laboratory	-

Location of resultant force; formula used is:
$d = (\Sigma Mt - \Sigma Mg) / (\Sigma W)$ .... (7)
Information:
Mt = Moment of resistance (ton.m)
Mg = Moment bolsters (ton.m)
W = vertical force (tons)
d = Point resultant work (m)

The amount of eccentricity can be calculated using the following formula:
$e = B / 2 - d < B / 6$ .... (8)
The stability of the carrying capacity of the foundation soil

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q1,2 = (Σ W / B) (1 ± ((6, e) / B) .... (9)
Information:

- W = vertical force (tons)
- B = foundation width (m)
- e = (B / 2 - d)

The formula to find the soil bearing capacity according to Terzaghi are:
qut = c. Nc + γ. Df. Nq + ½. γ. Breakfast. Nγ .... (10)
Information:

- c = Cohesion soil (kg/m2)
- γ = Heavy soil content (kg/m3)
- B = foundation width (m)
- Df = Depth of foundation (m)
- Nc, Nq, Nγ = coefficients carrying capacity

Table 3: Coefficients Carrying Capacity of Terzaghi

φ	Nc	Nq	Nγ	N'c	N'q	N'γ
0o	5,71	1,00	0	3,81	1,00	0
5o	7,32	1,64	0	4,48	1,39	0
10o	9,64	2,70	1,2	5,34	1,94	0
15o	12,8	4,44	2,4	6,46	2,73	1,2
20o	17,7	7,43	4,6	7,90	3,88	2,0
25o	25,1	12,7	9,2	9,86	5,60	3,3
30o	37,2	22,5	20,0	12,7	8,32	5,4
35o	57,8	41,4	44,0	16,8	12,8	9,6
40o	95,6	81,2	114,0	23,2	20,5	19,1
45o	172	173	320	34,1	35,1	27,0

EXPERIMENTAL SETUP

In this paper, the research data were grouped into two types of data: The primary data is raw data that has not undergone processing. Primary data consist of: measurements report and soil sampling, soil test results in the laboratory. Secondary data is data that has undergone processing, as illustrate in Figure 1

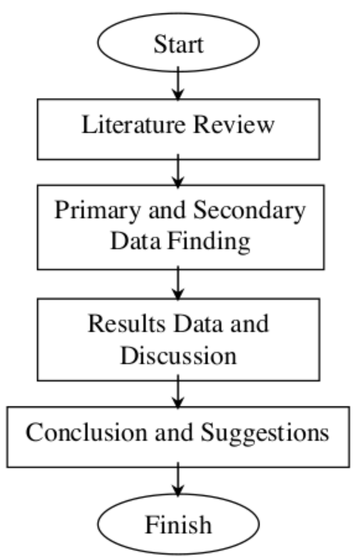

Fig. 1: Flow Chart of Research

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Research steps are as follows: 1) Take measurements at the research site, 2) Take soil samples at the sites, 3) Check the soil samples in the laboratory., 4) Results of laboratory examinations as a data computation required, 5) Plan dimensions and calculate the weight its own construction of a safety wall climbing counterfort, 6) Calculating ground pressure, 7) Calculate the load from loading, 8) Calculating stability counterfort cliff construction safety against bolster, 9) Calculating stability counterfort cliff construction safety against sliding, 10) Calculate the resultant layout styles, 11) Calculating the stability of the wall construction safety counterfort cliff on the carrying capacity of the soil foundation.

RESULT AND DISCUSSION

Topography measurement results on the field are 3 point observations made per 25 meters along 50 meters were recorded and the results of these measurements can be made sketches of the building elevation seat Mempura river cliff.

Table 4: Elevation Cliff Protection Structure

Location	Type Wall	Elevation (m)				
		Water Surface		Safety Cliffs Wall		
		Flood	Tides	Piling	Down	Up
Mempura River Village	Concrete	+ 0,80	+ 1,20	- 0,75	- 0,75	+ 2,25

Analysis of the stability of the cliff wall construction safety counterfort conducted to determine minimum safety factor of safety counterfort climbing against bolstering, sliding and carrying capacity of the soil in the research. Security wall climbing height planned 3 m with details of 0,2 m, thick bottom plate and 0,8 m, high buffer plate (counterfort), width of floor plate 1,5 m, and a width of the sloping side walls of 2,97 m. The calculations were performed to measure the strength of the security cliff wall as shown in table 5.

Table 5: Calculation of Stability Against Rolling and Sliding

		Vertical Force	Work Length	Lasting Moment	Horizontal Force	Work Length	Bolster Moment
		(kg)	(m)	(kg.m)	(kg)	(m)	(kg.m)
B.S concrete	Wv1 Wh1 W2	1.342,63 - 720,00	1,00 - 0,75	1.342,63 - 540,00	- 479,43 -	- 1,60 -	- 767,09 -
B.S soil	W3	2.646,00	1,17	3.095,82	-	-	-
Vertical force against soil pressure	Pv1 Pv2	-134,78 -106,34	1,00 0,83	-134,78 -88,26	- -	- -	- -
Horizontalforce againstsoil pressure	Ph1 Ph2 P3 P4	- - - -	- - - -	- - - -	-48,13 -37,97 -26,35 -10,48	1,60 1,13 0,10 0,07	-77,01 -42,91 -2,64 -0,73
Total		4.467,51		4.755,41	356,50		643,80
Fg to bolster		= Σ Mt / Σ Mg = 4.755,41 / 643,80 = 7,39 > 3……………………….					
Fs tosliding		= (Σ W . μ) / PH = (4.467,51 x 0,3) / (356,50) = 3,76> 3 ……………….					

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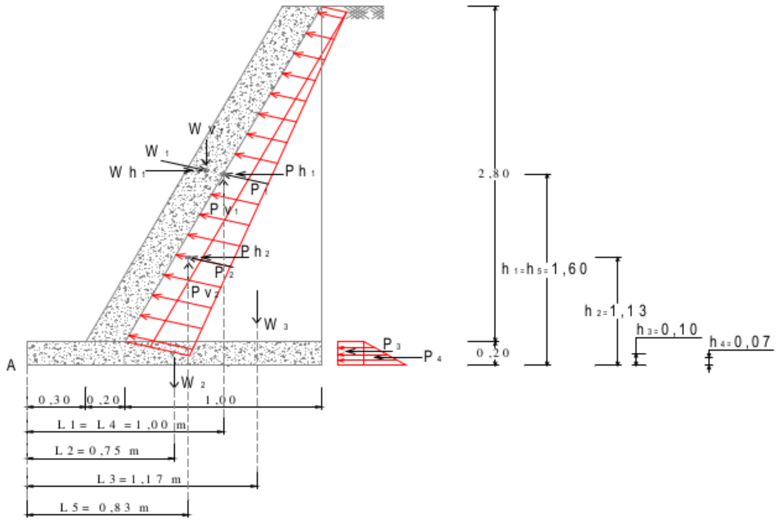

Fig. 2: Diagram Resultant Pressure Due to The Load

Selection of a safety wall climbing counterfort type for anchoring Mempura river cliff with some consideration. The main consideration is stronger when compared with the type of stone masonry and gabion. Moreover, this type, in addition to the concrete walls and tread to hold the soil, at a certain distance by the support plate to further strengthen the security of the building used cliff. With the support plates are then security climbing wall and the longitudinal direction of the floor plate has a higher resistance to rolling and sliding, in addition to its function as a buffer that strengthen the concrete retaining wall of the cliff. Plat cantilever made on the side wall of which is underground receiving help minimize ground pressure force acting on the slices lengthwise walls and the floor plate.

The cost factor is also a consideration that is no less important. When compared with other types of concrete walls such as gravity and spring-type gravity, then type counterfort require fewer concrete material that is considered more economical when used as a retaining wall climbing.

After calculating soil condition in the river cliff Mempura and the dimensions of the retaining wall climbing types counterfort strong to withstand the cliff then the dimension is planned; counterfort high retaining wall climbing 3 m with details (floor plate thickness of 0.2 m and a height from the surface of the floor plate 2.8 m); slab width of 1.5 m; wide concrete cliff sloping side seat 2.97 m (0.2 m thick concrete and the bottom is positioned 0.3 m from the end of the floor plate exterior).

Dimensions and strength of the wall has met the requirements and exceeded the minimum clearance of the safety factor against bolstering and sliding. Thus, the dimensions of the retaining wall climbing counterfort type are recommended as a barrier cliff Mempura River which still form the walls of the original land that has not been given a booster to avoid scouring water. The security walls climbing counterfort types capable of withstanding Mempura river cliff and avoid erosion by river water flowing continuously. Thus the historic site is located on a cliff top that can be preserved and protected from collapse caused by damage to the riverbank.

CONCLUSSION

The conclusion is as follows: the value of the safety factor against the bolsters of 7,39; safety factor against sliding value of 3,76; eccrintrisity value of -0,17; carrying capacity of land for q1 = 5.003,61 kg/m2 and q2 = 953,07 kg/m2.

Given the historical value of the research sites, it is suggested that the historical site preservation efforts can be realized well. Cliff suggested retaining wall is a retaining wall

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climbing counterfort type that has the power and the cost is more economical than other types of rock retaining wall.

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