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DESIGN OF LANDSLIDES TREATMENT WITH COUNTERFORT WALL ON CITY LIMITS ROADS TANAH GROGOT-LOLO KUARO, PASER REGENCY, TANA PASER, THE PROVINCE OF KALIMANTAN TIMUR

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ABSTRACT

The landslides occurred on city limits roads Tanah Grogot-Lolo Kuaro, Paser regency, Tana Paser, causing depletion of the smooth flow of transport from the city towards Grogot Lolo-Kuaro or vice versa. Landslides 8 meters height and 50 meters length. The landslides occurred in September 2015 caused by high rainfall and bad drainage system. So it needs to be done the landslides treatment using retaining wall with Counterfort.

The methodology of this planning, first to calculate the forces acting on the retaining walls of the soil due to traffic load and soil stockpile with method of Rankine. Continued calculation of the forces acting on the stake piles using the method of Meyerhoff and Skempton. Then do the calculations to determine the group efficiency of stake piles using Brooms method analysis. After the stake piles were declared safe against lateral load and bearing capacity, perform the calculation of reinforced concrete of soil retaining walls. After that the retaining walls and stake piles of the foundation soil is modeled and analyzed using the Geo Studio software to get the safety factor of the design. Lastly, the calculated volume of work and unit price of the retaining walls to get a budget plan costs.

After the retaining walls design brings about a result that is, the dimensions of the walls with 8 m height is 4.2 m width foot wall, 0.6 m high to the foot of the wall and the lower part of the wall width, 0.3 m width of to the top of the wall, 0.4 m for a width of Counterfort and 3 m for the distance between Counterfort with lateral load 63.756 tons. Stake pile received 25.867 tons of vertical load and 9.099 tons of lateral load. Safety factor of slopes after landslides treatment modelled with software Geo Studio, resulting in a value of safety factor 2.956 (> 1.25) which can be said to be secure. Based on the calculation of volume and unit price work, retaining wall Counterfort cost is Rp. 3,572,350,220.0-

Keyword: Landslide, Retaining Wall, Counterfort, Slopes Stability

1. INTRODUCTION

Landslide which occurred on roads Grogot Land city limits, has caused a reduction in the flow of transport. Also make these roads become less safe and comfortable to walk on. So it is considered necessary to do repairs / handling avalanches so the smooth mobilization can be achieved safely and comfortably back.

After further consideration based on the dimensions and characteristics of the avalanche, handling determined using the retaining wall to wall type Counterfort.The reason why the use of type Counterfort is because these are more economical to use with avalanche heights over 7 meters. In addition to the active earth pressure on a vertical wall large enough due to avalanches that reach a height of 8 meters.

The objective of this scheme is:

1. Knowing the dimensions of the retaining wall Counterfort.
2. Knowing the size of the force - the force that occurs as a result of lateral earth pressure.
3. Knowing the size of the force - the force acting on pile foundation?
4. Knowing the value *of safety factor* of the slope after handling.
5. Knowing the budget plan.

2. THEORITICAL STUDY

Avalanche *(slides)* is the slope forming material movement caused by the sliding, along one or more areas of landslides. The land mass that moves bias fused or broken - broken. Genesis mass movement is the mass transfer of soil and rock in the vertical direction, oblique or horizontally from its original position caused by the mass balance disorders at the time that moves downward through the sliding plane or slope forming material.

The loss of mass balance of soil and rocks on a slope can be caused by the influence geological, conditions inundated, physical properties of soil, earthquake and human activity

Foundation pile is construction parts made of wood, concrete and steel that is used to transmit the load-bearing surface to levels lower surface in the soil mass (Bowless, 1992).

The bearing capacity of piles with data approach sondir with method *Meyerhoff* . The safety factor is determined by the type of soil in sondir. While the bearing capacity of the pile with the approach of the laboratory data can be formulated for ultimate end bearing use methods *Skempton.*

Pile bearing capacity of friction *(frictionpile)* in the clay soil will be reduced if the pole distance is getting closer, several observations indicate that the total carrying capacity of pile groups friction *(frictionpile)*, often smaller than the product of single pile bearing capacity multiplied by the number of poles in the group. Thus, the magnitude of the total carrying capacity be reduced by reducing the value of which depends on the size, form, distance, and long poles. So used method *Converse-Labarre Formula*. Efficiency pile group can also be determined using a table of Kerisel. Efficiency then use the smallest of the formula *Converse-Labarre Formulas* or tables of *Kerisel.*

Ground lateral pressure there are three (3) types, namely:

1. Soil pressure at rest.
   Soil pressure caused by the land masses on the retaining wall in balance.
2. Active soil pressure.
   Pressure is trying to push the retaining wall to move forward.
3. Passive pressure.
   Pressure is trying to keep / keep active soil pressure.

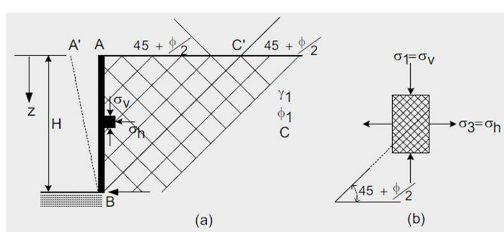

Figure 1. Active Soil Pressure

Ground pressure can also occur due to the load evenly on the ground.

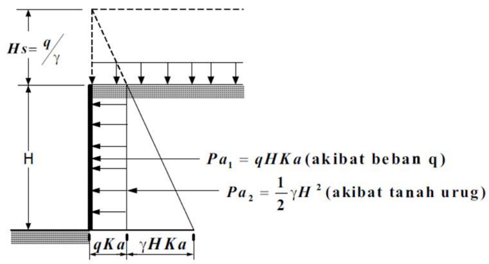

Figure 2. Pressure Land Charges Due Uneven

Retaining Walls is a building that serves to stabilize the specific soil conditions that are generally mounted on an unstable cliff area. This type of construction among others mortared stonework, rip rap, concrete, wood and sebaginya. The main function of the construction is to hold the soil retaining wall that stands behind the danger of landslides.

If the active earth pressure on a vertical wall is large enough, then the vertical wall and the heel needs to incorporate (Counterfort). Counterfort serves as a binder drag the vertical wall and placed on the heap with a certain distance interval. Counterfort wall would be more economical to use when the wall height of more than 7 meters.

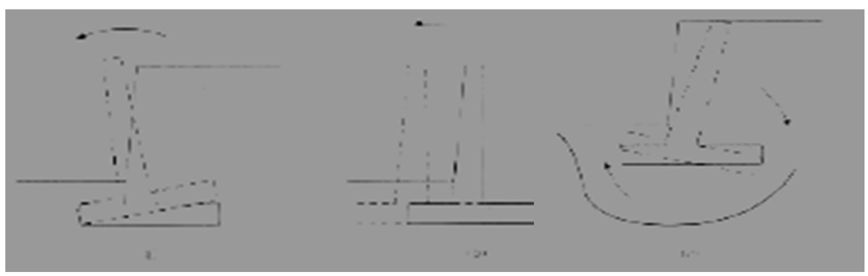

Figure 3. Retaining Walls stability

As seen in Figure 3. above, there are several things that can cause the collapse of the retaining wall, among others by overthrow, panning and collapse bearing capacity.

Lateral earth pressurecaused by urugan soil behind the retaining wall, tends to overthrow the wall to the center of rotation on the front foundation toe. The overthrow of the moment, opposed by the moment due to its own weight retaining wall and the moment due to heavy soil above the foundation plate.

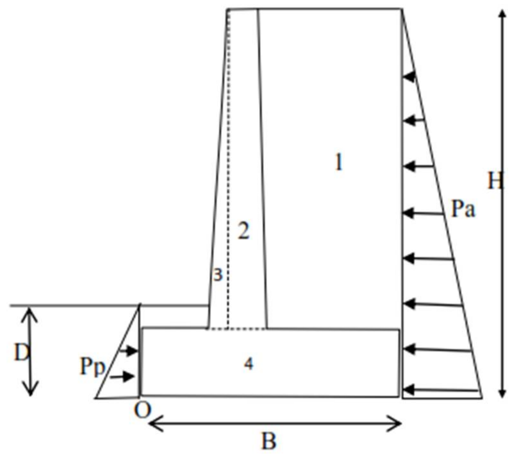

Figure 4. Soil Retaining Wall Stability of the Slide

Safety factor against rolling is defined as (in te rms of foot / O point in the image). Forces that shift the retaining wall will be retained bythe friction between the soil and foundation base, and a passive soil pressure in front of the retaining wall.

According to Firmansyah (2011: 25) in his book *Design Build Applications Budget Plan in House*Construction.Budget Plan (RAB) is a calculation of the amount of costs required for materials and wages, as well as other costs associated with the implementation of development projects.

The budget plan of a project is the calculation of the amount of costs required for materials and wages and other costs associated with the implementation of the building or project. (Bachtiar Ibrahim, 1993).

Two ways that can be implemented in the preparation of the budget include:

- Budget rough cost (estimated), as the guidelines used the unit price per square meter of floor space. But the rough cost budget can be also as a guide in the preparation of RAB calculated carefully.
- Conscientious cost budget, the project carefully and meticulously calculated in accordance with the terms and conditions of the preparation of the budget.

The volume of work is to count the number of times the volume of work in a single unit. Description of the volume of work is to describe in detail in the calculation of the volume of each - each work according to pictures and detailed bestek.

A place that has two ground surface have different heights and connected by a surface called the slope (Vidayanti, 2012). This slope can occur naturally or artificially. The slopes are slopes that occurs naturally and is naturally formed as a slope on a hill or river cliffs. While the slope of artificial is the slope created by humans as a necessity, whether made in the native land cutting through the ground like for highways, waterways, or the slope made of compacted soil such as dikes, dams soil (Ruskandi & Thamrin, 2003) ,

Slope stability can be taken into account to check the security of the natural slope, slope excavation and embankment slopes compacted. Factors that need to be made in the examination is to calculate and compare the shear stress is shaped along the crack surfaces are most likely to shear strength of the land concerned. This process is called analysis of slope stability.

Geoslope is program using limit equilibrium method for calculating the safety factor of a slope. The program is also able to calculate the safety factor of a field sloping ground. With this program we can analyze the problem, either simple or complex by using one of the eight methods equilibrium limits for various sloping surfaces, pore water pressure conditions, soil properties and a concentrated load.

With this program we can model the slope in the form of a drawing on a computer in the application of Computer Aided Design (CAD). After menginputt soil properties and material data analysis settings as desired. After the verification process if no input errors in inputting data. Then analyzed the data and models slope w solve. Displayed with the slope w contour and graphical display the entire field of landslides circular (circular) and the value of what is safe can be shown in the form of a safety factor (SF) as well as the diagram and polygons that can be seen in every field landslide margin.

3. METHOD

The method used is to evaluate the construction calculations based on design data to be used after that to settle matters with the planned construction of a wall of Counterfort using a pile foundation.

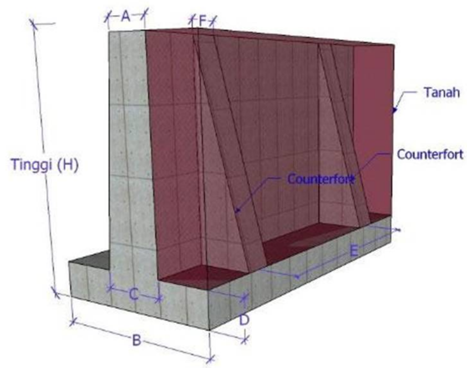

Figure 5. DimensionsWallCounterfort

WallCounterfort generally used when the retaining wall height (H) greater than 6 m. Distance counterfourt determined by trial - try and the most economical range between 0.4 - 0,7H. Thick top of the wall can be made about 0.20 to 0.30 m, with the following conditions:

A = 20 cm to 30 cm

B = 0,4H until 0,7H

C = H / 14 to H / 12

D = H / 14 to H / 12

E = 0,3H until 0,6H

F = Minimum20 cm

Width base retaining wall should be sufficient to mobilize the soil bearing capacity or in other words, the voltage due to the construction work plus styles - the other does not exceed the carrying capacity permits. The calculation of the structural strength of the construction of retaining wall, by examining the shear stress and the allowable compression stress on the structure of the retaining wall.

To overcome cracking other requirements that must be met is the minimum thickness of concrete cover.

Steps reinforcement retaining wall is as follows:

1. Calculate β_1.
2. Calculate the nominal moment (Mn)

3. Calculate the ratio of reinforcement necessary
4. Calculate the reinforcement ratio maximum
5. Calculate reinforcement ratio minimum
6. Calculate the area of reinforcement needed
7. Calculate the distance flexural main
8. content distance between flexural main
9. control requirements ductility

4. RESULTS AND DISCUSSION

Geometric data from avalanches, landslides high note (H) = 3.6 to 8.0 m. Determination of the dimensions of retaining wall is divided into 3 mode. Type 1 to a height of 8 to 6.5 m, Type 2 to a height of 6.4 to 4.9 m and Type 3 for the height of 4.8 to 3.6 m.

Table 1. Dimensions Wall

	Type 1	Type 2	Type 3
A (m)	0.3	0.25	0.2
B (m)	4.2	3	2.4
C (m)	0.6	0.5	0.4
D (m)	0.6	0.5	0.4
E (m)	3	2.4	2
F (m)	0.4	0.35	0.3

Installationof piles tested with pole diameter (D) = 300 mm with depth by *End Bearing* (H) = 6.2 m with the formation of the pole and the center of gravity of piles as needed per type.

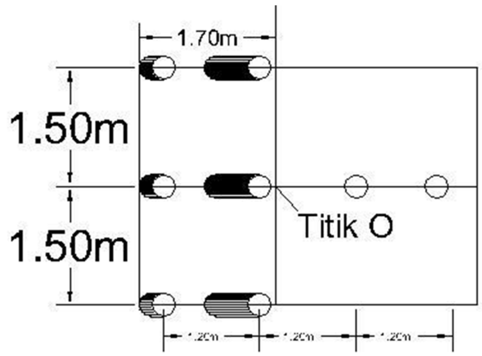

Figure 6. Plan Piles Type 1

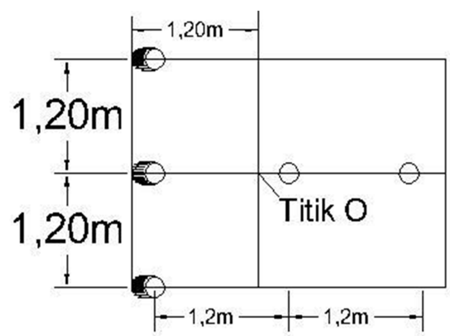

Figure 7. Plan Piles Type 2

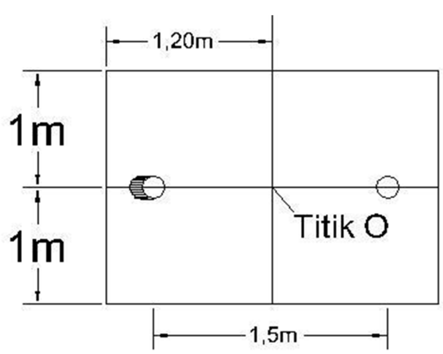

Figure 8. Plan Type 3Piles

The calculation soil pressure behind the wall is affected by soil embankment load and load evenly. Calculation of earth pressure is calculated based on the method Rankine

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Table 2. Active Soil Pressure behind the Wall

	Type 1	Type 2	Type 3
Active Soil Pressure (tons)	63.756	33.707	16.6632
Moment Due to Land On (tm)	181.29	77.586	29.27232

Calculation vertical style and the style can be seen as a moment of its own weight structure and soil embankment above the retaining wall.

Table 3. Style Vertical and Moment

	Type 1	Type 2	Type 3
Vertical Style (tonnes)	113.782	53.198	26.774
Due Moment Style Vertical (tm)	132.586	44.33	11.291

Distributi on the style against the pole is calculated using the formula:

$$\frac{\Sigma v}{n} + \frac{Myx}{\Sigma x}$$

So we get the following results:

Table 4. Distribution Style to Pole type 1

Tipe 1	Vertikal (ton/tiang)	Aksial (ton/tiang)	Lateral (ton/tiang)
Baris 1	25,867	25,996	9,099
Baris 2	19,95	20,049	9,099
Baris 3	14,033	14,033	9,099
Baris 4	8,116	8,116	9,099

Table 5. Distribution of Style of Column type 2

Tipe 1	Vertikal (ton/tiang)	Aksial (ton/tiang)	Lateral (ton/tiang)
Baris 1	20,8578	20,9618	7,384
Baris 2	10,78	10,78	7,384
Baris 3	0,7023	0,7023	7,384

Table 6. Distribution Style to Pole type 3

Tipe 1	Vertikal (ton/tiang)	Aksial (ton/tiang)	Lateral (ton/tiang)
Baris 1	25,3744	25,501	7,0473
Baris 2	1,3986	1,4055	7,0473

Based on the method *Meyerhoff* for calculation of data taken sondir at point S-1, namely:

qc = 150 kg / cm^2

JHP = 634 kg / cm

D = 30 cm

A = 706.5 cm^2

K = 94.2 cm

SF1, 3 = SF2 = 5 (for the soil material such as sand)

SF1, = 3-5 SF2 = 5-10 (for soil materials such as clay)

Used SF1 = 3, SF2 = 5

$$Q_{izin} = \frac{A \times qc}{SF1} + \frac{JHP \times K}{SF2}$$

$$= \frac{706{,}5 \times 150}{3} + \frac{634 \times 94{,}2}{5}$$

$$= 47269{,}56\ kg = 47{,}26\ ton$$

Based on laboratory data with methods *Skempton* custody of the pile obtained by:

Nc = 9 (Skempton 1959), karenal / D> 5

Ab = ¼. π. D^2 = ¼ x 3.14 x 0.3^2

= 0.07065^2 m

Qb = Ab.Cu. N c = 0.07065 x 48.95 x 9

= 31.125 t

For frictional resistance pole using α, λ and β:

Table 7. Prisoners Swipe Pole

[redacted]	λ β		α
Prisoners Swipe (tonnes)	39.813	84.179	8.23

So that used the amount of pile bearing capacity and the smallest frictional resistance:

Qu = Qb + Qs = 31.125 + 8,23

= 39.355 tons

Formula *Converse - Labarre*:

m = 2

n = 4

d = 30 cm

s = 120 cm

Ø = arctan $\frac{d}{s}$ = 14.036

$$E_g = 1 - \theta \frac{(n-1).m + (m-1).n}{90.m.n}$$

$$= 1 - 14{,}036 \frac{(4-1).2+(2-1).4}{90.2.4} = 0{,}806$$

While the *Kerisel* table results obtained:

Table 8. efficiency factor Column

Jarak pusat ke pusat tiang	Faktor efisiensi (E_g)
10d	1
8d	0,95
6d	0,9
5d	0,85
4d	0,75
3d	0,65
2,5d	0,55

Efficiency value of 0.75. So use poles efficiency factor of 0.75.

Control Vertical Load Carrying Capacity To

Know:

Q_{ult} = 39.355 ton

eff = 0.75

$Q_{of\ work}$ = 25,91ton (maximum vertical load single pole)

$Q_{permission.}$ = Q_{ult}Eff = 39.355 tons.

0.75 = 29.52 tons

$Q_{permits}$29.52 tons=> Q_{work} = 25.894 tons (safe)

Controls Supports Power Pole against Lateral Load

Know:

$H_{working}$ = 9.09 tonnes

L = 6 m

d = 0.3 m

C_u = 2.55 tonnes / m^2

Q_u = 0.3928 kg / cm^2

fy = 2400 kg / cm^2

w = 744 cm^3

E = 210000 kg / cm^2

I = 11900 cm^4

n_h = 415.5 kN / m^3(Davisson-Prakash)

$$T = \sqrt[5]{\frac{EI}{nh}} = \sqrt[5]{\frac{210000.11900}{415,5}} = 22,6 \text{ cm} = 0,226 \text{ m}$$

L = 6 m $\geq$ 4T = 0.226 = 0.68 m 4.

Thus considered as a rigid pole (long pole).

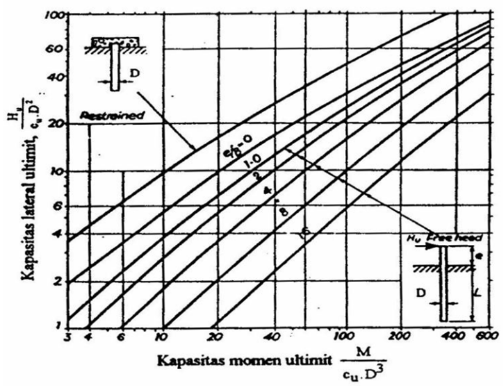

Figure 9. Graph *Brooms*

Withmethod *Brooms* with the graph $\frac{M_y}{C_u.d^3}$is obtained:

$$\frac{H_u}{C_u.d^3} = 63$$

$$H_u = 63.C_u.d^2 = \frac{63\,.\,0{,}255\,.\,30^2}{1000}$$

$$= 14{,}175\ ton$$

$H_{safe} = \frac{H_u}{Sf} = \frac{14{,}175}{1{,}5} = 9{,}45\ ton$> H_{work} = 9,09 ton (secure)

For reinforcement wall is obtained as follows:

Type 1

- foot wall section (pieces II and II-II)
  - Mu = 275.532kN.m
  - Vu = 279.774 kN
  - Tul. Top = D25-200
  - Tul. Share = D19-300
  - Tul. Scroll = φ19-250
- body part wall
  - Mu kN.m= 191.268
  - Vu = 212.52 kN

- Tul. Top = D22-150
- Tul. Share = D16-350
- Tul. Scroll = φ16-150 / 300

- Part lattice / Counterfort (pieces III-III)
  - Mu = 832.4 kN.m
  - Vu = 360.36 kN
  - Tul.Main 125= 3D25-
  - Tul. Share = D19-200
  - Tul. Scroll = φ19-300

Type 2

- foot wall section (pieces II and II-II)
  - Mu = 155.75 kN.m
  - Vu = 167.17 kN
  - Tul. Top = D25-250
  - Tul. Share = D19-350
  - Tul. Scroll = φ19-200
- body wall section
  - Mu = 80.89kN.m
  - Vu kN= 140.448
  - Tul. Top = D19-125
  - Tul. Share = D16-350
  - Tul. Scroll = φ16-150 / 300
- Part lattice / Counterfort (pieces III-III)
  - Mu = 832.4 kN.m
  - Vu = 360.36 Kn
  - Tul.Main 100= D25-
  - Tul. Share = D19-300
  - Tul. Scroll = φ19-300

Type 3

- foot wall section (pieces II and II-II)
  - Mu = 88.434kN.m
  - Vu = 117.272 kN
  - Tul. Top = D25-325
  - Tul. Share = D19-500
  - Tul. Scroll = φ19-150
- body wall section
  - Mu = 33.264 kN.m
  - Vu = 83.16 kN
  - Tul. Top = D16-125
  - Tul. Share = D10-250
  - Tul. Scroll = φ10-150 / 300
- Part lattice / Counterfort (pieces III-III)
  - Mu = 142.85 kN.m
  - Vu = 99,8 kN
  - Tul.Main 125= D25-
  - Tul. Share = D19-350
  - Tul. Scroll = φ19-300

For the initial conditions before the avalanche slope was not analyzed because the slopes are experiencing landslides have *safety factor* of less than 1.25. As well as the limitations of the data geometric slope and soil parameters on the slopes. Slope stability analysis is used as a measure of whether the handling of the landslides that occurred already has *safety factor* exceeded theof 1.25. In other words can dikatan slopes safe for traveling or used as is.

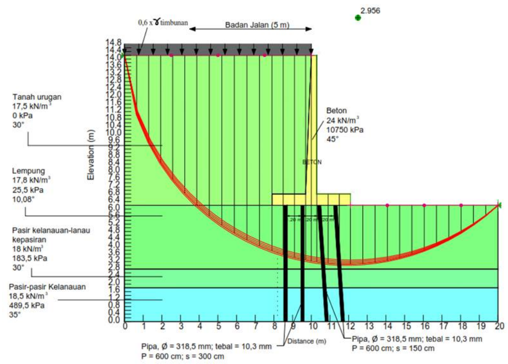

Figure 10. Modeling Slope with Software GeoStudio

Having analyzed using software GeoStudio SF values obtained after treatment amounted to 2.956 so it can be said safely.

Based on the calculation of work volume and unit price analysis of the price obtained for budget Rp.2.547.940.589,00 plan.

5. CONCLUSION

1. Counterfort soil retaining walls are divided into three types. Type 1 to a height of 8 to 6.5 m, type 2 to a height of 6.4 to 4.9 m and type 3 for the height of 4.8 to 3.6 m. The width dimension of the upper wall of 0.3 m, width of the bottom wall and foot wall height of 0.6 m, width foot wall 4.2 m, width 0.4 m lattice and lattice spacing between 3 m for the highest retaining wall (type 1).
2. Lateral forces that occur as a result of soil and load evenly on the back wall is 63.756 tons for type 1, type 2 33.707 tons and 16.632 tons for Type 3.
3. The forces acting on the piles to the walls of 25.867 tons of type 1, type 2 for 20.8578 tons and 3 types of 25.3744 tonnes capacity vertical force allowable 29.52 tons so it can be said safely. While lateral forces that occur in type 1 amounted to 9.099 tonnes, amounting to 7.3840 tons of type 2 and type 3 by 7.0473 tons and lateral force permitted by 9.45 tonsmethods *Brooms* and 17.532 tonswith methods *Nafvac DM-7* so it can be said safely.
4. The value of *safety factor* slopeafter treatment with Counterfort and analyzed using the *software* geo studio obtained a value of 2.956> 1.25 so it can be said safely.
5. From the calculation of the budget plan using the Basic Unit Price Activity (HSPK)

Paser 2016 and use the Job Analysis Unit Price (AHSP) in 2013 obtained the total cost of construction of Retaining Walls Land Rp. 2547940589, -

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