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EVALUATION OF THE DESIGN OF RETAINING WALLS ON THE ROAD SUKABUMI (BAROS) - SAGARANTEN KM BDG 115+200

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ABSTRACT

The Sukabumi (Baros) – Sagaranten Km Bdg 115+200 road section which is located in Sukabumi Regency is a road section for the province of West Java. Because the road is always damaged due to being eroded by water infiltration in the rice fields that seeps into the road body area at that location and the soil at that location tends to be unstable based on the results of lab tests having a shear angle value of 4.99^o and having a specific gravity of 17.45, then it is carried out analysis of the existing damaged retaining wall and the design of a new gabion-type retaining wall at that location. The gabion retaining wall building will be designed with 3 designs, the first using a stone volume of 13 m3, the second using a stone volume of 8 m3 and the third using a stone volume of 6.5 m3. Based on the results of the calculation analysis using Rankine theory, it was found that the existing retaining wall was unable to withstand the shearing force which got a check value of 1.18 which should have a value of SF > 1.5, while the 3 gabion plan buildings got the appropriate SF value, namely against the overturning force, shear force and soil bearing capacity.

Key word: retaining wall; gabions; roads.

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INTRODUCTION

The highway is a land route on the surface of the world made by humans with the shape, size and development so that it can be utilized properly for the traffic of individuals, creatures, and vehicles that transport products from one place to the next in an effective and fast manner (Clarkson). H. Oglesby, 1999). Road Complementary Buildings are buildings that support road capacity and safety which include extensions, boats, bridges, underpasses, parking areas, canals, retaining barriers, and road side channels that are carried out as needed. (Regulation of the Minister of Public Works of the Republic of Indonesia Number 13/PRT/M/2011 concerning Procedures for Road Maintenance and Supervision). This research was conducted on the Sukabumi (Baros) – Sagaranten Km Bdg 115+200 road, which is already known and felt by many people who cross the road that there is a station (STA) that suffers from repeated damage to the road body, this is evidenced by data measure the survey results using a total station measuring instrument which shows the cross section of the road has a grade that is not ideal. Several treatments have been carried out on these roads but the results are still nil, therefore it is necessary to evaluate and study the history of handling on these roads to find out the cause of the continuous damage, so that an alternative solution is obtained which further determines the planning as solutions that can improve transportation mobility. Based on the existing problems and facts, this research was conducted as a step to evaluate the design of retaining walls for complementary roads on Jalan Sukabumi (Baros) - Sagaranten KM BDG 115+200".

RESEARCH METHODS

Survey activities are carried out based on data needs, in general the stages contained in this research include; (1) Research Locations (2) Data Collection; (3) Data Analysis (4) Comparison of Analysis Results. The location of this research was carried out on the Sukabumi (Baros) – Sagaranten Km Bdg 115+200 road section, West Java. The stages and procedures that will be carried out in this research are as shown in Figure 1.

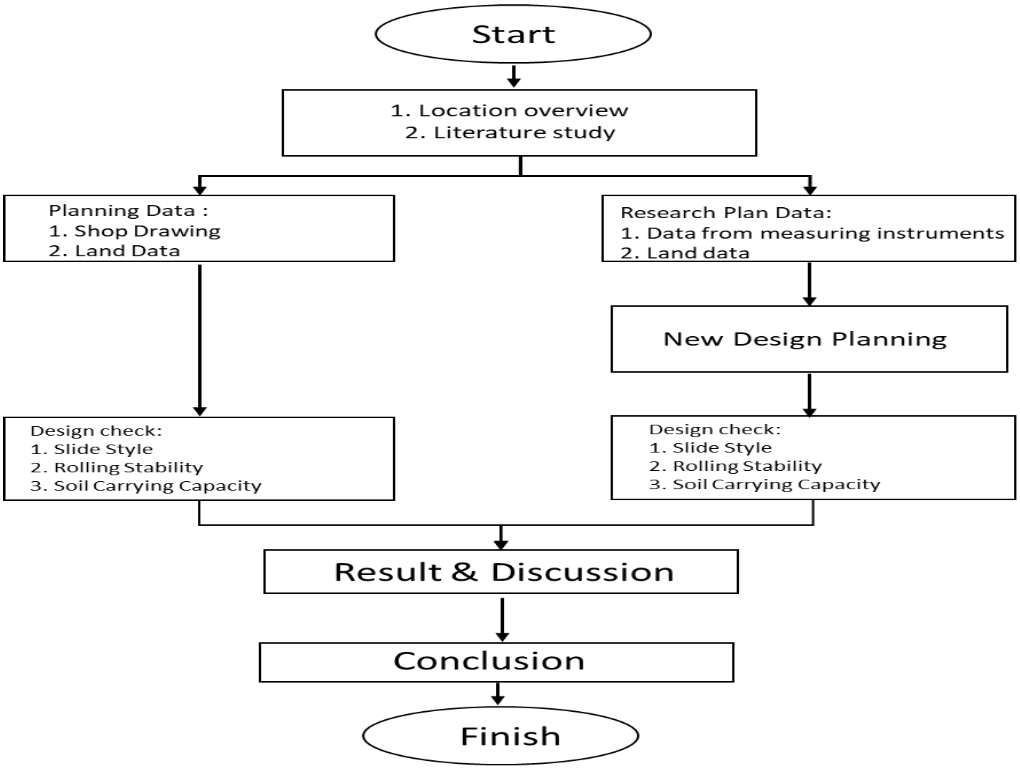

Figure 1. Research Flow Chart

RESULT AND DISCUSSION

Location Overview

Site reviews need to be carried out to see real field conditions, to find out suitable handling in the field and to find out the condition of the community in the location to the problems that exist at the location. which had previously been obtained from the Department of Highways and Spatial Planning of West Java Province, then only a site review was carried out and coordinated with residents around the location, according to residents' reports it can be concluded that the cause of damage to existing road complementary buildings is caused by groundwater originating from the rice fields can be described as follows through Figure 2.

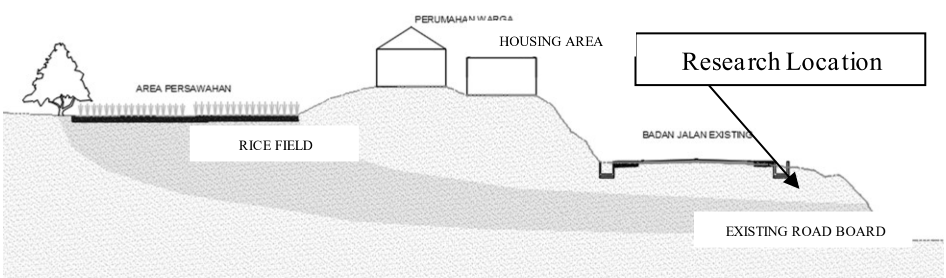

Figure 2. Cross Section Situation And Illustration Conditions Below Ground

Soil Data

Because the design of the gabion building and the height of the slope to be handled has a height of 3.00 m, the soil data used is soil data from the borlog test with a depth of 1.50 – 2.00 m. And for embankment soil data, general embankment soil data is used. For recapitulation of land data used can be seen as follows:

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Table 1. Soil Data Depth 1.50 – 2.00 m

γt (kN/m3)	**γd (kN/m3)**	**N (kN/m3)**	**Φ (°)**	**C (kN/m3)**	**Qc**	**q (kN/m2)**
17,45	12,08	5,38	4,99	15	383,6	10

(Source: Department of Highways and Spatial Planning of West Java Province)

t = 17.45 kN/m^3

d = 12.08 kN/m^3

n = 5.38

= 4.99 °

c = 15 kN/m^2 = 0.15 kg/cm^2

soil bearing capacity

Qc = 383.6 Kn/m^2 = 3.836 kg/cm^2

There is additional uniform load on the ground (traffic)

q = 10 kN/m^2 = 0.1 kg/cm^2

Steps of Analysis and Planning

In conducting an analysis of the existing retaining wall and making a design design, the researchers used the same method, namely the simplified and simplified Rankine method.

Dividing Dimensions Into Multiple Components

To facilitate analysis or planning, the dimensional components are separated into several parts, the symbols and their meanings are as follows:

- H = Total height.
- H1 = Height of retaining wall from ground level
- H2 = Height from below ground level to surface
- land.
- B = Total width of the base of the retaining wall.
- BB = Base that fits the width of the top of the building.
- B1 = is from the end of the BB to the end of the retaining wall building.
- BA = Width of the building.

Determining Soil Coefficient

The soil coefficient will be used to calculate active and passive soil pressure, the coefficient of soil value is obtained based on the soil conditions obtained from the lab test results, namely the shear angle value with the symbol, and with the Rankine method used, active and passive soil coefficients will be obtained.

- Active Soil Coefficient $Ka = Tan^2 (45 – (\phi \times 2)/2)$
- Passive Soil Coefficient $Kp = Tan^2 (45 + \phi\ 1/2)$

Calculating Active Earth Pressure
Consequences of Additional Even Load (Pa1)

The soil pressure obtained from the uniform load can be interpreted as the load originating from the road body, the road shoulder and the surrounding area, and from traffic, HS is the coefficient of the uniform load from the soil conditions in the area which is worth 10/12.08, for The calculation of the active earth pressure from the additional uniform load is:

$$Ka.\gamma d.Hs.H$$

- Ka, coefficient of active earth pressure
- d, weight of dry soil.
- Hs, coefficient of uniform load on dry soil
- H, the overall height of the building

Effect of Soil Behind the Wall (Pa2)

The earth pressure behind the wall is the horizontal load of the resisted slope.

$$1/2.Ka.\gamma d.H.H$$

- ½ because the load from behind the ground is triangular because the higher the load, the smaller the load, but the lower the load, the greater the load.
- Ka, coefficient of active earth pressure
- γd, weight of dry soil.
- H, the overall height of the building

Effect of Water Behind the Wall (PW)

The pressure that comes from the water contained in the soil, because water has its own burden, the load must be analyzed.

$$1/2.n.H$$

- ½ , because the load from behind the soil is triangular because the higher the load, the smaller the load, but the lower the load, the greater the load.
- n, porosity is the percentage of total pores in the soil occupied by water and air, can be interpreted as soil water content
- H, the overall height of the building

Calculating Passive Ground Pressure (Pp)

Passive pressure is determined by the depth of the foundation and soil strength, because this passive pressure will later be used as resistance to active earth pressure, the analysis is as follows:

$$Kp.\gamma d.(h2).(h2)$$

- ½ , because the load from behind the ground is triangular because the higher the load, the smaller the load, but the lower the load, the greater the load.
- Kp, Coefficient of passive earth pressure.
- d, Weight of dry soil.
- H2 = Height from below ground level to surface land.

Check Against Bolster

Overturning moment (Mo) is the value of the moment that can result in overturning of the retaining wall, the analysis is as follows:

$$Mo = (Pa1.H/2) + (Pa2.H/3) + (PW.H/3)$$

- Pa1 = Active earth pressure from additional uniform load.
- H/2 = The overall height of the building is divided by 2 because the load is evenly distributed

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- depicted as a box.
- Pa2 = Effect of Soil Behind the Wall

H/3 = The overall height of the building is divided by 3 because the load is evenly distributed

- depicted as a triangle

PW = Effect of Water Behind the Wall

- Weight of Earth Retaining Wall
- Density of masonry /m^3 = 22kN

Weight of masonry retaining wall = Volume . Specific gravity

- Specific gravity of gabions /m^3 = 20kN
- Gabion specific gravity = Volume Specific gravity

Calculating Safety Factor

$$Mb/Mo > 1.5$$

Mb = Overturning moment, can be interpreted as the moment of resistance to the overturning moment.

$$Mb = R \cdot Arm$$

R = Weight of components obtained from specific gravity times the volume of components

Component = Part of dimension separated based on center of gravity analysis

Center of gravity = This center of gravity can be determined based on the distribution of the mass of the object's particles, each of which has a certain weight. The center of gravity is at the point where the resultant moment of each particle's gravitational force is zero.

Check Against Sliding Style

The shear force comes from a horizontal push which can cause the retaining wall to be displaced, the analysis of the shear force is as follows:

Shear Force (Ho)

Ho = Shear force obtained from the combined active earth pressure.

Ho = Pa1 + Pa2 + Pw

Sliding Retention Style

Hb = The value of the friction coefficient of the retaining wall (μ) multiplied by the total weight of the retaining wall building and then added passive earth pressure

Hb = (μR) +Pp

Calculating Safety Factor

Hb/Ho > 1.5

- Check Against Soil Bearing Capacity

Eccentricity, the effect of eccentricity load on the bearing capacity of the foundation in the presence of an eccentricity load, this can affect the bearing capacity of the foundation.

e = (B/2) - ((Mb-Mo)/R)

The eccentricity value is determined by the width of the base of the retaining wall and the weight of the retaining wall.

Qmin is the minimum total vertical load, having a greater value because it has less load to support due to its position at the inner end of the retaining wall.

Qmin = (R/B) . (1- (H. e/B))

Safety Factor is obtained from:

$$SF = \frac{Qc}{Qmin} = \frac{borlog}{Total\,minimum\,vertical\,load}$$

Qmax is the maximum total vertical load, has a smaller value because it has more load supported because its position is at the outer end of the retaining wall.

Qmax = (R/B) . (1+ (3,5 . e/B))

Safety Factor is obtained from:

$$SF = \frac{Qc}{Qmax} = \frac{borlog}{Total\,maximum\,vertical\,load}$$

Result of Existing Design Analysis and Plan Design

After doing a design analysis on the existing design and making a design and analyzing the Design Plan, results are showing that the existing retaining wall which is of the type of gravity retaining wall is incompatible with checking for shear, checking for overturning, and checking for soil bearing capacity, while Design The plan that has been designed showing the suitability of the check against shear, check for overturning and check the bearing capacity of the soil for the recapitulation of the design check numbers can be summarized in Table 2.

Table 2. Comparison of Design Check Results

No	Design Check	Existing Design	1st Design	2nd Design	3rd Design	Required Value
1	Overthrow	1,537	7,02	4,65	4,24	> 1,5
2	Sliding Style	1,188	3,002	2,31	1,88	> 1,5
3	Eccentricity	0,399	0,054	0,13	0,00115	> B/H
4	Qmin	10,40	6,23	8,48	8,87	> 3
5	Qmax	6,90	5,599	6,429	8,84	> 3

Based on the results of the analysis, the existing retaining wall failed when checking the shear force, while the check value for overturning and the bearing capacity of the soil was by the required value. The first, second, and third plans that have been designed have successfully passed all stages of checking to start from checking for overturning, checking for shear forces, and checking for soil bearing capacity.

Making 3 design plans aims to make comparisons that are more varied so that effective and efficient designs will be found, the efficiency of the design uses an indicator of the volume size of each design plan, the smaller the volume of the design, the more effective and efficient. In addition to the cost budget used, it will be more efficient, the duration of the construction work will be faster because the volume of work is reduced, therefore the researchers recap the volumes of the first, second and third designs, which can be seen from Table 3 below:

Table 3. Plan Design Volume

No	Name of Design	Volume (M')
1	1st Plan Design	13
2	2nd Plan Design	8

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3	3rd Plan Design	6,5

CONCLUSION

Dimensionally, the existing design of this retaining wall already has criteria that are by the concept of a gravity type retaining wall in general, the damage to this design is caused by the soil conditions at the research site which have unstable and has a high soil water content is evidenced by the results of the analysis of the shear that does not meet the minimum SF value. Another cause is retaining walls Stonemasonry soil cannot drain groundwater properly because the pores of the retaining wall only rely on distilled water, causing groundwater to accumulate. Settles causing the soil to saturate and resulting in strong shear & overturning forces to the existing building. The suitable retaining wall for this location is a gabion retaining wall or gabion wall because the gabion retaining wall has large pores so that it can drain water from the soil which is identified as coming from the residents' rice fields. The results of the analysis of the existing design proved that it did not meet the minimum SF requirements for checking shear forces, while the design plan that had been designed in the form of 3 gabion-type retaining wall designs had met the minimum SF requirements for overturning forces, shear forces, and soil bearing capacity. The plan design that has high effectiveness is the third design, because it has the least gabion volume requirement.

REFERENCES

Adhi Surya, Muhammad Fikri Azhar dan Abdurrahman, 2021. Perencanaan Dinding Penahan Tanah Pada Jalan Gubernur Syarkawi (SP. Empat Handil Bakti – Bypass Banjarmasin), Universitas Islam Kalimantan Muhammad Arsyad Al Banjari Banjarmasin. (Indonesian).

Andi Muh. Alam Kangkong, Sulha, Umran Sarita, 2020. Analisis Perhitungan Stabilitas Bronjong Dan RAB, Tugas Akhir, Politeknik Negeri Jakarta, Depok. (Indonesian).

Bowles, Joseph E, 1989. Sifat-sifat Fisis dan Geoteknis Tanah, (Mekanika Tanah), Erlangga, Jakarta. (Indonesian).

Clarkson H, Oglesby, 1999, Alih Bahasa, Teknik Jalan Raya Jilid 1, Gramedia, Jakarta. (Indonesian)

Das, Braja M. 1993. Mekanika Tanah (Prinsip prinsip Rekayasa Geoteknis). Erlangga, Jakarta. (Indonesian)

Das, B., M., (Noor Endah, Indrasurya B. Mochar) 1995. Mekanika Tanah (Prinsip-Prinsip Rekayasa Geoteknis) Jilid I Cetakan Pertama, Penerbit Erlangga, Jakarta. (Indonesian)

Das, B., M., (Noor Endah, Indrasurya B. Mochar) 1996. Mekanika Tanah (Prinsip-Prinsip Rekayasa Geoteknis) Jilid II Cetakan Pertama, Penerbit Erlangga, Jakarta. (Indonesian)

Edrick Tanuwijaya, Aksan Kawanda dan Hendy Wijaya 2019. Studi Kolerasi Nilai Tahanan Konus Sondir Terhadap Parameter Tanah Pada Proyek Di Jakarta Barat, Universitas Tarumanagara, Jl. Letjen S. Parman No.1 Jakarta. (Indonesian)

Enden Mina, Woelandari Fathonah, Fricha Desy Candra Sari 2019. Analisis Stabilitas Dinding Penahan Tanah Untuk Perkuatan Tebing Badan Jalan Suradita – Kranggan, Skripsi, Universitas Sultan Ageng Tirtayasa, Cilegon. (Indonesian)

Hardiyatmo, H. C. 2003. Mekanikah Tanah II Jilid 3. Gadjah Mada University Press, Yogyakarta. (Indonesia)

Hardyatmo, H.C, 2010. Mekanika Tanah II Edisi V, Gadjah Mada University Press, Yogyakarta. (Indonesian)

Masriani Endayanti, Krisman Marpaung, S, 2019. Analisis Perkuatan Lereng Dengan Menggunakan Dinding Penahan Tanah di Skyland Jayapura Selatan, Universitas Darma Agung. (Indonesian)

L.D.Wesley (1977). Mekanika Tanah, cetakan VI, Badan Penerbit Pekerjaan Umum. (Indonesian)

Mahasiswa Program Studi Teknik Sipil, Fakultas Teknik, UWKS. Dosen Program Studi Teknik Sipil, Fakultas Teknik, UWKS. 2019. Perencanaan Ulang Dinding Penahan Tanah Underpass Mayjend Sungkono Surabaya. Program Studi Teknik Sipil, Fakultas Teknik, Universitas Wijaya Kusuma Surabaya. (Indonesian)

Maria Febe, Imam Hariadi Sasongko, 2019. Analisis Stabilitas Dinding Penahan Tanah Dengan Perkuatan Bronjong Pada Jalan Tol Ulujami – Pondok Ranji Ramp Bintaro Viaduct, Tugas Akhir, Politeknik Negeri Jakarta, Depok. (Indonesian)

Melania Kalalo, Jack H. Ticoh, Agnes T. Mandagi, 2017. Analisis Stabilitas Dinding Penahan Tanah (Studi Kasus: Sekitar Areal PT Trakindo, Desa Maumbi, Kabupaten Minahasa Utara). (Indonesian)

Muh. Tahir, Ratna Musa, 2020. Kajian Koefisien Kekasaran Manning (n) Pasangan Batu dan Beton Berdasarkan Kuantifikasi Kekasaran Hidrolis (Studi Kasus Daerah Irigasi Wawotobi Kab. Konawe Sultra) Program Studi Teknik Sipil Fakultas Teknik Universitas Muslim Indonesia. (Indonesian)

Muhammad Nurdin, 2019. Evaluasi Tikungan Di Ruas Jalan Dekso – Samigaluh, Kabupaten Kulon Progo, Skripsi, Universitas Negeri Yogyakarta. (Indonesian)

O'Rourke, T. D. & Jones, C. J. F. P., 1990. Overview of Earth Retaining Systems: 1970 – 1990. Design and performance of earth retaining structures: proceedings of a conference / sponsored by the Geotechnical Engineering Division of the American Society of Civil Engineers in cooperation with the Ithaca Section, pp. 22-51.

Reyhana Almira Rahma, Mardewi Jamal, Heri Sutanto, 2020. Analisis Stabilitas Lereng Pada Ruas Jalan Samarinda Balikpapan Km.24 Dengan Alternatif Perkuatan Dinding Bronjong Dan Geotekstil, Skripsi, Universitas Mulawarman, Samarinda. (Indonesian)

Sang Gumilar, 2020. Tanah Longsor Dan Upaya Pencegahannya, Media Sarana Sejahtra, Sukuharjo. (Indonesian)

Surono. 2009. Litostratigrafi Pegunungan Selatan Bagian Timur Daerah Istimewa Yogyakarta dan Jawa Tengah. Publikasi Khusus Geologi Pegunungan Selatan Bagian Timur. Kementerian Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Survei Geologi. Bandung. (Indonesian)

Tjokorda Gde Suwarsa Putra, Made Dodiek Wirya Ardana, dan Made Aryati., 2020, Analisis Stabilitas Lereng Pada Badan Jalan Dan Perencanaan Perkuatan Dinding Penahan Tanah, Skripsi, Universitas Udayana, Denpasar. (Indonesian)

Zuul Fitriana Umari1, Bahder Djohan2, Andri Subaktio3 2019, Desain Pondasi Dengan Menggunakan Batu Kali Pada Jalan Sekayu-Betung. (Indonesian)