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Foreward

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This journal publishes the results of research, studies, concepts, and policies in the field of civil engineering that has never been published through a peer review process by reliable reviewers in the related field with a national and international reputation.

In this edition, JTS publishes 11 articles that have been selected and considered to be of high quality and meet standards with various themes. Hopefully, in the subsequent editions, JTS can publish more quality articles.

Pontianak, June 17, 2022

Best regards,

Dr. Stefanus B.S., S.T., M.T., IPM
Editor in Chief

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CONTENTS

Jurnal Teknik Sipil: Vol 22-No. 1, June 17, 2022, page 01-page 04
Department of Civil Engineering, University of Tanjungpura
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Sediment Characteristics Of Bed Load Transport In Mahap River Of Nanga Mahap Sub-District, Sekadau Regency, Indonesia

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Abstract

Sedimentation is a crucial factor in river problems. Sediment can cause silting of the river so that its capacity be reduced and can cause overflow of water to the surface. Every year, Districts of Nanga Mahap at Sekadau Regency always experiences flooding and the problem is still happening up until now. One of the causes of the occurrence of flooding in Nanga Mahap District is the overflow of the Mahap River. This study aims to determine the characteristics and rates of bottom sediment transport in the downstream of the Mahap River. Sediment collection was carried out at 8 segments of the estuary. In this study, laboratory tests were carried out regarding specific gravity and grain size of sediment particles refers to the texture classification by USDA (U.S. Department of Agriculture) and freight rate calculations Basic Sediment with Duboys Method. Based on characteristic analysis Mahap River sediments obtained the average D50 sediment grain diameter value from all research points that is equal to 1.63 mm, the results of testing the specific gravity the average obtained are 2.754 gr/cm3 so that it can be classified in the form of coarse grains with a type of sand sediment. The largest base sediment transport rate of bed load occurred at point 2 of 8.816 tons/day and the smallest was at point 7, which is 0.154 tons/day. From the calculation, result shows that if the velocity of falling particles is greater than the river water flow velocity, therefor the sediment particles will settle.

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pervious concrete, physical and mechanical properties, variation of aggregate, with sieving, without sieving

1. Introduction

Nanga Mahap Village is located in the District of Nanga Mahap, Sekadau Regency, West Kalimantan province. The area of Nanga Mahap District is 1,196.49 km2. Nanga Mahap village is crossed by two rivers, namely the Mahap River and the Sekadau River. The confluence of the two rivers separates three villages, namely Seberang Sekadau Village, Soket Village and Engkayak Village. The confluence of these two rivers is causing the Nanga Mahap Village to be vulnerable to flood ing, especially when it rains with high intensity and causing the two rivers to overflow and inundated the Nanga Mahap Village. According to data from the Regional Disaster Management Agency of Sekadau Regency, the biggest flood that ever occured in the Nanga Mahap Village in 2009 was 3 meters high. Floods occur continuously every year until now. In 2018, there was a flood with a height of 1.5 meters. The flood submerged 6 villages including Nanga Mahap, Batu Pahat, Banyan Valley, Tembesuk, Teluk Kebau and Landau Kumpai. In 2021 there was a 1 meter high flood in Tembesuk village due to the all-day rain.

One of the causes of flooding is silting of the river due to the sedimentation process. The presence of excess sediment can affect the characteristics of rivers and cause problems related to human life such as flood and subsidence water quality. Transport rate transfer process sediment causes siltation due to sedimentation that empties downstream.

Sedimentation can be in the form of floating sediment (suspended load) and bottom sediment (bed load). The sedimentation rate is not only influenced by sediment characteristics (particle size, specific gravity and velocity fall) is also affected by the discharge that passes through The cross section of the river flow, where the flow rate is a function of the depth of flow, river width and river slope (Hambali, 2016).

Based on the problems above, it is necessary to know the condition of the Mahap River so that the problem of flooding in the local area can be resolved. Therefore, it is necessary to study the characteristics and sedimentation rate of the Mahap River.

2. Material and Method

This type of research is quantitative research with the method used in this study in the form of field observations. This implementation begins from from surveying the research site, sampling, to data

analysis. The research subjects are sample of bottom sediment (bed load).

2.1. Location of Research

This type of research is quantitative research with the method used in this study in the form of field observations. This implementation begins from surveying the research site sampling, to data analysis. The research subjects are sample of bottom sediment (bed load). To facilitate research, ,the research location is divided into 8 segments with a distance of 300 m, each segment being 2.1 km long. The sampling points can be seen in Figure 1. in the following.

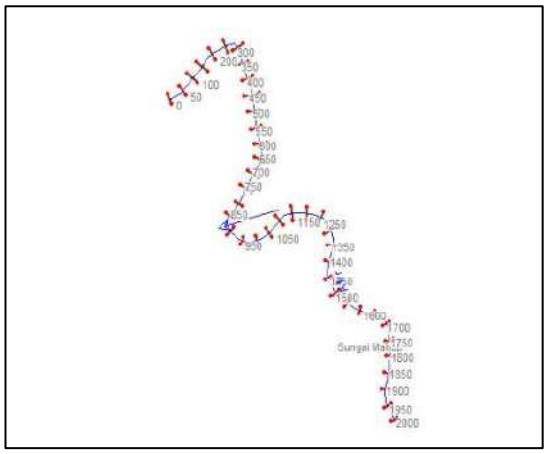

Figure 1. Sampling point (Leonardo, 2020)

2.2. Research Prosedure

Broadly speaking, the stages of research can be seen in the flow chart below:

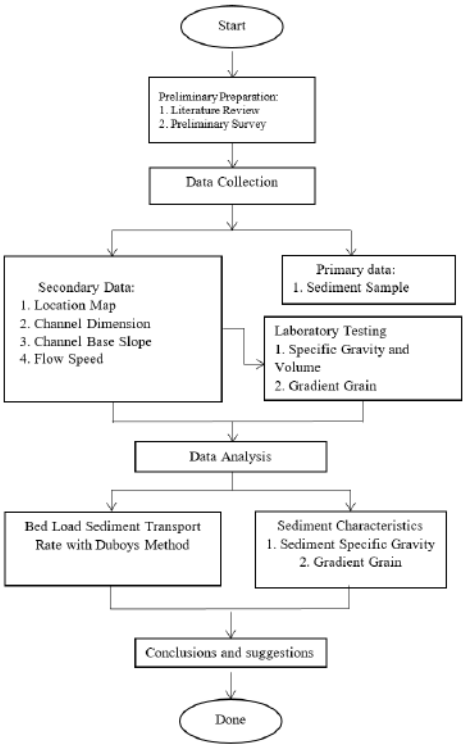

Figure 2. Flow Chart

2.3. Sample Collection Technique

Basic sampling (bed load) uses a jar. The jar is then be drowned to the bottom of the river with the top covered tightly and against the river flow direction. After approaching the riverbed, the jar will be opened until it is fully filled up, and then it will be closed again. Each jar then will be labeled with a name according to the segment and point of sediment extraction. Base sediment sample will then be sent to the Soil Mechanics Laboratory of Tanjungpura University for Gradation and specific gravity .

2.4. Data Analysis

Based on the results of laboratory tests, we analysed the data as follows:

a. Knowing the specific gravity and granules refers to the texture classification by USDA (U.S. Department of Agriculture).

b. Calculation of Basic Sediment Transport with the Duboys Method.

3. Result and Disscussion

3.1. Analysis of Sediment Characteristics

In general, the prediction of the sediment transport rate is based on the characteristics of the sediment which consist of particle size, specific gravity and particle falling velocity. Sediment characteristics can be explained by identifying the sediment characteristic variables, so that the rate of sediment transport in the Nanga Mahap River can be estimated.

3.1.1. Gradation Of Sediment

The following is the result of the recapitulation gradation of D35, D50, and D50 at each study point.

Table 1.Gradation Recapitulation of D_{35}, D_{50}, and D_{90}

Gradation	Point 1 (mm)	Point 2 (mm)	Point 3 (mm)	Point 4 (mm)	Point 5 (mm)	Point 6 (mm)	Point 7 (mm)	Point 8 (mm)	Average (mm)	Description
D35	1,53	0,79	1,04	2,68	0,21	0,57	0,36	1,20	1,05	Sand
D50	2,35	2,00	1,55	4,00	0,26	0,79	0,45	1,60	1,63	Sand
D90	7,60	10,55	5,80	9,40	0,60	5,40	4,00	4,25	5,95	Gravel

From the results of the sieve analysis test, it is known that the sediment passes through the sieve number 200 (0.075) < 50%. Therefore, from the test results of the sieve analysis we can get the value of the sediment's uniform grain diameter which is D_{50}. The average D_{50} sediment grain diameter value is from all research points that is equal to 1.63 mm. So, it can be classified in the form of granules coarse with sand type sediment.

3.1.2. The Density Of Sediment

Assessment of sediment characteristics can also be seen from the value of the density. The results of sediment density testing in the laboratory can be seen in the following table.

Table 2. Recapitulation of Sediment Density

Titik	No. Sampel	Gs (ton/m3)
1	STA 0+000	2,801
2	STA 0+300	2,827
3	STA 0+600	2,811
4	STA 0+900	2,743
5	STA 1+200	2,766
6	STA 1+500	2,699
7	STA 1+800	2,684
8	STA 2+100	2,698

Specific gravity test results obtained the average is 2.754 gr/cm^3. Based on the value of the weight, the sediment type of the Nanga Mahap River turned out to be a type that is included in the category of sand types.

Mahap River sediments are affected by the pollution caused by PETI operations in the upper part of Nanga Mahap River (Ranty et al, 2019). As a result, the pollution affects the change in density of the sediment. This can also affect the density obtained.

The table below is a classification sample of sediment characteristics at the bottom of the Nanga Mahap River.

Table 3. Basic Sediment Sample Classification

Point	Spesific Weight (ton/m3)	Diameter (mm)			Classification		
		35	50	90	silt (mm)	Clay (mm)	Sand (mm)
					<0,002	0,002 - 0,06	0,06 - 2,00
1	2,801	1,53	2,35	7,60	0,75		99,25
2	2,827	0,79	2,00	10,55	0,25		99,75
3	2,811	1,04	1,55	5,80	0,93		99,07
4	2,743	2,68	4,00	9,40	0,30		99,70
5	2,766	0,21	0,26	0,60	4,98		95,02
6	2,699	0,57	0,79	5,40	1,67		98,33
7	2,684	0,36	0,45	4,00	1,14		98,86
8	2,698	1,20	1,60	4,25	0,75		99,25

3.1.3. Fall Velocity

The falling velocity of the sediment particle is the final sediment velocity that settles. As for the particles that are not spherical, the speed of the fall can be expressed with:

$$w = \left[\frac{gd^2}{18v}\right]\left(\frac{\rho_s - \rho_w}{\rho_w}\right)$$

Wherein:

w = fall velocity (m/s)
g = gravitational acceleration = 9,81 m/s^2
ds = diameter of the particles (mm)
ρs = density of the particles (kg/m^3)
ρw = density of the water (kg/m^3)

The following are the results of the calculation of the sediment fall velocity from Point 1 to Point 8:

Tabel 4. Fall Velocity Calculation Result

No	Position	D_{50} (m)	ρs kg/m³	ω m/s
1	2	3	4	5
1	STA 0+000	0.00235	2801	6.45
2	STA 0+300	0.00200	2827	4.74
3	STA 0+600	0.00155	2811	2.82
4	STA 0+900	0.00400	2743	18.07
5	STA 1+200	0.00026	2766	0.08
6	STA 1+500	0.00079	2699	0.69
7	STA 1+800	0.00045	2684	0.22
8	STA 2+100	0.00160	2698	2.82

From the table above, it is found that the highest of the falling velocity is at Point 4 which is 18.07 m/s while the lowest falling speed is at point 7 at 0.22 m/s.

3.2. Sediment Rate Analysis (Bed Load) Duboys Method

The use of Duboys method equation is based on the average particle size parameter sediment and critical frictional stress. The particle size ranges from 0.1 mm to 4 mm (Soemarto, 1999). The results of the calculation of the bottom sediment rate obtained the following results:

Table 5. Sediment Rate Analysis (Bed Load) with The Duboys Method

No	Position	V (m/s)	ρ_s (kg/m³)	S	D (m)	D50 (m)	Rb (m)	b m	τ kg/m^2	τ_c kg/m^2	ψ'	q_b (m³/s/m)	Q_b (m³/s)	Q_b (ton/day)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	STA 0+000	0.500	2801	0.00096	0.242	0.00235	0.103	31.00	0.232	0.044	37.059	1.62E-06	5.01E-05	0.391
2	STA 0+300	0.370	2827	0.00238	0.530	0.00200	0.300	42.20	1.260	0.044	23.556	3.61E-05	1.52E-03	8.816
3	STA 0+600	0.290	2811	0.00079	0.955	0.00155	0.493	42.00	0.753	0.044	14.228	7.60E-06	3.19E-04	1.846
4	STA 0+900	0.260	2743	0.00099	0.767	0.00400	0.384	31.60	0.758	0.044	32.122	1.74E-05	5.49E-04	4.119
5	STA 1+200	0.360	2766	0.00093	0.658	0.00026	0.380	38.00	0.611	0.044	2.915	1.01E-06	3.83E-05	0.241
6	STA 1+500	0.650	2699	0.00101	0.488	0.00079	0.492	33.30	0.494	0.044	15.606	3.46E-06	1.15E-04	0.807
7	STA 1+800	0.920	2684	0.00071	0.355	0.00045	0.213	24.30	0.253	0.044	12.512	6.63E-07	1.61E-05	0.154
8	STA 2+100	0.650	2698	0.00116	0.587	0.00160	0.311	23.10	0.680	0.044	31.595	1.36E-05	3.15E-04	3.179

Below the calculation Analysis bottom sediment will be described at point 5 (STA 0 + 200):

- Depth of the riverbed (d) = 0,658 m.
- Width of the riverbed (b) = 38 m.
- The slope of the riverbed (S) = 0,00093.
- Speed of the riverflow (V) = 0,360 m/det.
- Density of the sediment (ρs) = 2766 kg/m^3 = 2,77 ton/m^3.
- Density of the water (ρw) = 1000 kg/m^3 = 1 ton/m^3.
- Granule Size D_{50} = 0,00026.

The calculation steps of the Dubois Method are as follows:

- Calculate the basic frictional stress (τo)

τ_o = ρw x d x S

τ_o = 1000 x 0,658 x 0,00093

τ_o = 0,611 kg/m^2

- Calculate the critical basic frictional stress (τc).

  Critical base frictional stress value (τc) is obtained from the mean grain diameter of the sediment.

  Sediment average grain diameter base (D_{50}) is 1.63 mm and the value of critical basic frictional stress (τc) is 0.044 kg/m2 (table 5 above).

- Calculate the parameter value of the particle size function (ψ')

$$\psi' = \frac{\rho s \text{ x } D_{50}\, x\, V}{2\ \tau c}$$

$$\psi' = \frac{2766 \text{ x } 0{,}00026\, x\, 0{,}36}{2 \text{ x } 0{,}44} = 2{,}941$$

- Calculate the value of the bottom sediment (qb)

$$qb = \psi' \frac{\tau o}{\rho w} \left(\frac{\tau o - \tau c}{\rho w}\right) qb$$

$$2{,}941 = \frac{0{,}611}{1000} \left(\frac{0{,}611 - 0{,}044}{1000}\right)$$

$$= 1{,}02 \text{ X } 10^{-6} \text{ m}^3\text{/s/m}$$

- Calculate the sediment transport rate across the width basis (Qb) by multiplying the value of bottom sediment (qb) By the river width (b), specific gravity (ρs) and 86400 sec/day.

Qb = qb x b x ρs x 1 day

Qb = 1,02 x 10-6 m3/s/m x 38 m x 2,77 ton/m3 x 86400 s/day

Qb = 0,243 ton/day

From Table 4. above it can be seen that the rate of the largest sediment transport occurs at point 2 of 8.816 tons/day. As for point 7, the smallest is 0.154 tons/day. For more details can be seen in the following image:

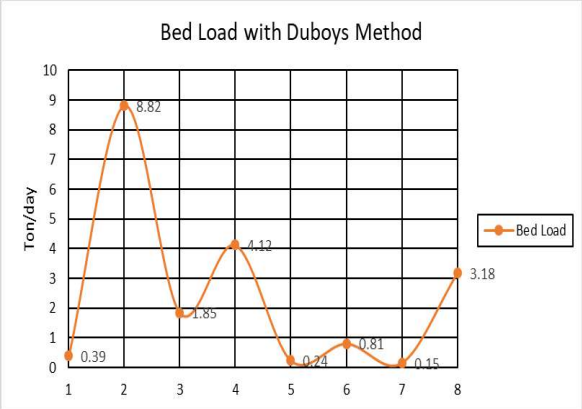

Figure 3. Mahap River Sediment Transport Rate (Bed Load) Using The Duboys Method

4. Conclusion

Based on the analysis of river sediment characteristics, it is easy to get the value of the diameter of the sediment grains D_{50} average of all research points i.e., of 1.63 mm, the results of the specific gravity test obtained the average is 2.754 gr/cm3 so it can be classified as coarse grain with sand sediment type. The largest bed load occurs at point 2 of 8.816 tons/day and the smallest is at point 7, which is 0.154. ton/day. The calculation results show that if the falling velocity of the particles is greater than the velocity of the river water flow, therefor the sediment particles will settle.

5. Aknowledgments

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6. REFERENCES

Asdak, C. (2007). **Hidrologi dan Pengelolaan Daerah Aliran Sungai**. Yogyakarta: Universitas Gajah Mada.

Hambali, R. (2016). **Studi Karakteristik Sedimen dan Laju Sedimentasi Sungai Daeng-Kabupaten Bangka Barat**. Jurnal Fropil Vol 4 Nomor 2, 173.

Hardiyatmo, H.C. (2012). **Tanah Longsor dan Erosi**. Gadjah Mada University Press, Yogyakarta

Cristoforus, Leonardo. (2020). **Analisis Kapasitas Dan Debit Banjir Sungai Mahap Serta Permodelan Alirannya Menggunakan Hec-Ras**. Skripsi Jurusan Teknik Sipil Universitas Tanjungpura. Pontianak

Mokonio, O. (2013). **Analisis Sedimentasi di Muara Sungai Saluwangko di Desa Tounelet Kecamatan Kakas Kabupaten Minahasa**. Jurnal Sipil Statik Vol.1 No.6, Mei 2013 (452-458) ISSN: 2337-6732, 7.

Christiana, Ranty; Anggraini , Ika Muthya and Syahwanti, Hezliana (2020). **Analisis Kualitas Air dan Status Mutu Serta Beban Pencemaran Sungai Mahap di Kabupaten Sekadau Kalimantan Ba**rat. Jurnal Serambi Engineering, Volume V, No. 2, April 2020 hal 941-950

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Identification Of Cultural Tourism Attractions Of Sekadau Hilir District, Sekadau Regency

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Abstract

Tourism is one of the important sectors in the development of Indonesia, especially in cultural attractions. Cultural heritage tourism in Sekadau Regency, West Kalimantan Province consists of 4 tours, 2 of which are located in the center of the district capital, namely Lawang Kuari Cave and King of Sekadau Tomb. Both tours are potential historical sites to be developed as ODTW (Objects and Tourist Attractions) in Sekadau Regency. The cultural attractions of Sekadau Hilir District have problems in the form of unregulated cultural attractions to the characteristics of the district. The data analysis method used is qualitative descriptive analysis, which is reviewed based on variables: attraction, facilities, support, and additional services. Based on the results of identification, known that ODTW culture in Sekadau Hilir District consists of (1) art, (2) a livelihood system, (3) cultural tourism festivals, (4) palaces, and (5) sites, buildings, and historical monuments. The driving factor for the development of cultural tourism is the availability of cultural attractions that can attract tourists, both from the tourist of internal and outside the area. Inhibiting factors in the development of cultural tourism are lack of promotion, lack of availability of infrastructure and tourism support facilities, and inadequate human resources.

Article history:
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Identification; Tourist Attractions; Cultural Tourism; Sekadau

1. Introduction

Tourism is one of the potential resources that can generate foreign exchange for the country and can be developed for the region (Astuti P., 2017). West Kalimantan Province has tourism potential consisting of natural tourism, agrotourism, cultural tourism, and special interest tourism. The existence of these objects and tourist attractions makes West Kalimantan designated as the top 10 national tourist destinations (Perda, 2019). Travel activities carried out by a person or a group of people or so-called tourists by visiting a particular place for recreational purposes, personal development, or learning the uniqueness of tourist attractions visited for a temporary period is the definition of tourism (Government Regulation, 2016).

Sekadau residents come from the Daranante group that runs along the Kapuas River led by Singa Patih Bardat and Patih Bangi and is a Dayak ethnic. The entry of Islam during the leadership of King Sultan Anom made the Dayak people who adhere to Islam claim to be Malays ethnic called Dayak Senganan. The name "Sekadau" is taken from the name of the wooden tree that grows around the river, and by residents is called "Batang Adau" (Susanti S, 2015). The history became part of the culture of the region and became an icon of Sekadau Regency as "Bumi Lawang Kuari". The naming comes from the Lawang Kuari Cave cultural heritage located in Seberang Kapuas Village, Sekadau Hilir District.

Cultural heritage tourism in Sekadau Regency consists of 4 tours, 2 of which are located in the center of the district capital, namely Lawang Kuari Cave and King of Sekadau Tomb. Both tours are potential historical sites to be developed as ODTW (Objects and Tourist Attractions) in Sekadau Regency (Perda, 2015). As the capital of Sekadau Regency, Sekadau Hilir District also has cultural heritage objects in the form of the King of Kematu Tomb, Penanjung Hanging Snapper, Jami'At-Taqwa Mosque, Cannon of Sekadau former Kingdom, Tegkorak House, Lawang Kuari, Tomb of King Sultan Anum, and Ceromin Office. The existence of cultural heritage in Sekadau Hilir District is a witness to the history of the establishment of the Sekadau Kingdom in the past. Tourism development in Sekadau Regency has problems in the form of unregulated cultural attractions to the characteristics of the district (Perda, 2016).

The cultural attractions of Sekadau Hilir Regency is not in accordance with the existing characteristics and potentials, so there is a need for a cultural ODTW identification study. Based on these potentials and problems, there is a need for research on "Identification of Cultural Tourism Attractions of Sekadau Hilir District, Sekadau Regency".

This research aims to examine the characteristics, potential, and problems of cultural tourism attractions in Sekadau Hilir District, Sekadau Regency.

There are 3 ODTW studies related and reference material in this study. Other research that is also a reference material is the Development of Infrastructure for Cultural-Based Tourism Destinations in West Java (Ghani, Y.A. 2017) and the Development Strategy of Mempawah Mangrove Park (MMP) of Mempawah Hilir Regency (Marjayanti, A. et al, 2020). The similarity of this research with the first research is the type of cultural tourism, and the variables used are also sub-variables used in this study, in the form of tourism facilities and infrastructure, tourism support facilities, infrastructure, and culture. The analysis method used is also a descriptive method with a qualitative approach, while the difference is in the purpose and location of the research study. The second research also has similarities in the form of objectives (ODTW identification), variables (attractions, facilities, supporting facilities, utilities, and accessibility), and research methods using descriptive analysis with a qualitative approach. Research differences are found in the type of tourism in the form of nature tourism and research locations located in Mempawah Regency.

The research that is considered most related to this research is the Identification of Objects and Tourist Attractions (ODTW) of Taman Kelempiau, Sekadau Hilir District, Sekadau Regency (Putri, T.A. et al, 2021.). This research has similarities in the location of the Sekadau Hilir district area, the purpose and results of research related to tourism identification, the same variables as this study are attractions, accessibility, and amenities. The research methods used also have similarities in the form of descriptive analysis with a kualialitative approach. The difference is in the type of tourism studied in the form of nature tourism, while this study examines cultural tourism. The novelty of this study is based on the very related research in the form of types of cultural tourism and sampling techniques used by purposive sampling and snowball sampling that make the diversity of information obtained.

The data collection method in this study consists of literature studies, observations, interviews, and documentation. The sampling techniques used in the sampling process in this study are purposive sampling and snowball sampling. The data analysis method used is qualitative descriptive analysis to find out cultural attractions in Sekadau Hilir District, Sekadau Regency. Activities in qualitative data analysis are carried out interactively and take place continuously until complete, including reduction and presentation of data, and conclusion drawing/verification.

Tourism development in Sekadau Regency, especially in cultural attractions, has not had a related development study. This research is important to produce a study on the development of information about cultural tourism in Sekadau Hilir District, Sekadau Regency. The benefits resulting from this study are the availability of a study of the identification of cultural tourism attraction objects in terms of regional planning as the basis for planning the tourism sector in Sekadau Regency.

2. Data and Methods

2.1. Data and Analysis Methods

2.1.1. Overview of Cultural Tourism Location in Sekadau Hilir District

Sekadau Hilir District is the Capital of Sekadau Regency (IKK), West Kalimantan, Indonesia. The government center of Sekadau Hilir District is located in Sungai Ringin Village. Geographically Sekadau Hilir District is geographically located between 00 18' 0" North Latitude – 00 6' 0" South Latitude and 1100 43' 30" - 1110 9' 0" East Longitude. Sekadau Hilir District is divided into 17 administrative villages. The population of Sekadau Hilir District in 2019 was 67,827 people, with a ratio of males to females of 104 people, or 104 males in every 100 females (Profile of Sekadau Hilir District, 2020).

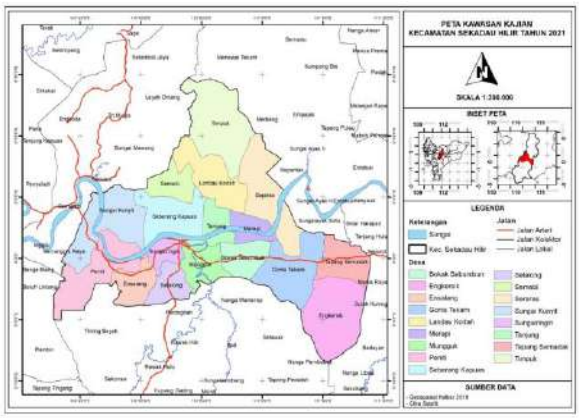


Fig 1. Map of The Study Area of Sekadau Hilir District

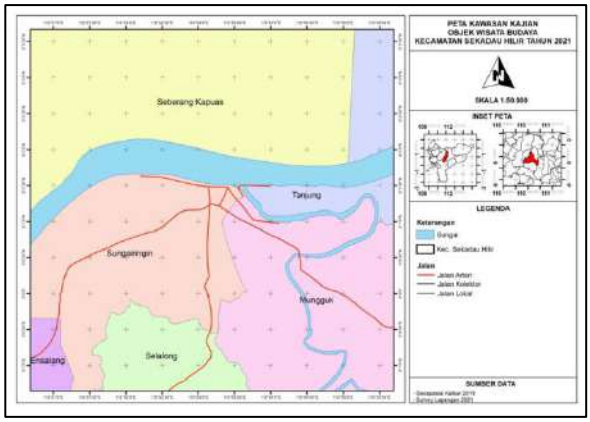


Fig. 2. Map of Cultural Attraction Study Areas of Sekadau Hilir District

2.1.2. Related Policies

The Regional Medium-Term Development Plan (RPJMD) of Sekadau Regency in 2016-2021 states that there are still no cultural attractions that are character-owned by the people of Sekadau Regency. Cultural and tourism priority programs in Sekadau

Regency are divided into tourism destination development programs, partnerships, cultural wealth, cultural values, cultural wealth management cooperation, cultural diversity, and tourism marketing. These programs are expected to increase the tourism sector's contribution to the value of GDP (Perda, 2016). There are 33 tourist attractions in Sekadau Regency in the Tourism Master Plan (RIPPDA) of Sekadau Regency in 2008.

Table 1. Distribution of Tourist Attractions in Sekadau Regency

Object Name	Type	Location/Area	Distance from the Capital	Uniqueness
Lawang Kuari Cave	Natural Tourism	Dusun Teribang, Seberang Kapuas Village, Sekadau Hilir	5 km	Natural Panorama
Gunam Springs	Natural Tourism	Dusun Bokak, Gonis Village, Sekadau Hilir District	9 km	Natural Panorama
Merah River	Natural Tourism	Gonis Tekam Village, Sekadau Hilir District	12 km	Natural Panorama
Engkaluk Lake	Natural Tourism	Dusun Seraras, Seraras Village, Sekadau Hilir District	20 km	Natural Panorama
Seginam Cascade	Natural Tourism	Dusun Kaki Riam, Sekonau Village, Sekadau Hulu District	28 km	Natural Panorama
Pelabuh Waterfalls	Natural Tourism	Dusun Tembawang Nangka, Tapang Perodah Village, Sekadau Hulu District	35 km	Natural Panorama and Springs
Semirah Merambang Waterfalls	Natural Tourism	Dusun Belandung, Tinting Boyok Village, Sekadau District	26 km	Natural Panorama
Waterfalls	Natural Tourism	Dusun Kelampuk Village, Meragun, Nanga Mahap	72 km	Natural Panorama
Sosah Kain Waterfalls	Natural Tourism	Dusun Tembaga,Belitang Hulu District	67 km	Natural Panorama
Seburuk Angkat Waterfalls	Natural Tourism	Dusun Seburuk, Seburuk Village, Belitang Hulu District	122 km	Hot Springs
Etugun Waterfalls	Natural Tourism	Dusun Tembaga, Belitang Hulu District	67 km	Natural Panorama
Gurong Sumpir Waterfalls	Natural Tourism	Dusun Sumpit, Merbang Village, Belitang Hilir District	45 km	Natural Panorama,
Menyumbung Waterfalls	Natural Tourism	Dusun Pinyak, Pinyak Village, Belitang Hilir District	36 km	Natural Panorama
Ulu Manjang Waterfalls	Natural Tourism	Dusun Pait, Serabas Village, Nanga Mahap District	73 km	Natural Panorama
Teng Aik Waterfalls	Natural Tourism	Dusun Cenayan, Cenayan Village, Nanga Mahap District	70 km	Natural Panorama,
Sirih Pupuk Waterfalls	Natural Tourism	Dusun Landau Mentawak, Pantok Village, Nanga Taman	60 km	Natural Panorama
Tujuh Sambung (Sirin Meragun) Waterfalls	Natural Tourism	Dusun Meragun, Meragun Village, Nanga Taman District	42 km	Natural Panorama
Batu Jatoh Waterfalls	Natural Tourism	Dusun Pantok, Pantok Village, Nanga Taman District	40 km	Natural Panorama
Bangkai Cascade	Natural Tourism	Dusun Landau Kumpai, Landau Kumpai Village, Nanga	80 km	Natural Panorama
Batu Bertulis	Cultural Tourism	Dusun Pait, Sebabas Village, Nanga Mahap District	42 km	Historical and
Tiang Sandong	Cultural Tourism	Dusun Seraras, Seraras Village, Sekadau Hilir District	25 km	Cultural Relics
King of Sekadau Tomb	Cultural Tourism	Dusun Mungguk, Mungguk Village, Sekadau Hilir District	2 km	Cultural Relics
Tomb of King Berenggang and King	Cultural Tourism	Dusun Perongkan, Perongkan Village, Sekadau Hulu District	25 km	Cultural Relics
Rumah Panjang Landau Kodah	Cultural Tourism	Dusun Landau Kodah, Seberang Kapuas Village,	7 km	Cultural Relics
Rumah Panjang Sungai Antulu	Cultural Tourism	Dusun Sungai Antu, Belitanag Hulu District	135 km	Cultural Relics
Pasah House dan Tanggak Bengkong	Cultural Tourism	Boti Village, Sekadau Hulu District	34 km	Cultural Relics
Ceromin Office	Cultural Tourism	Sungai Ringin Village, Sekadau Hilir District	1 km	Cultural Relics
Bukong Traditional Tomb	Cultural Tourism	Dusun Pait, Desa Sebabas, Nanga Mahap District	69 km	Cultural Relics
Pemirah Waterfalls	Natural Tourism	Natai Ubah Village, Sekadau Hulu District	26 km	Waterfalls
Gurong Sumpit Waterfalls	Natural Tourism	Merbang Village,Belitang Hilir District	36 km	Natural Panorama
Batu Dalang Sei Ayak Lake	Natural Tourism	Sei Ayak 1 Village, Belitang Hilir District	36 km	Natural Panorama
Padung Sei Ayak III Lake	Natural Tourism	Sei Ayak 3 Village, Belitang Hilir District	36 km	Natural Panorama
Tomb of the King and Jami Mosque	Cultural Tourism	Seberang Kapuas Village, Sekadau Hilir District	7 km	Cultural Relics

2.2. Types of Cultural Tourism in Sekadau Hilir District

2.2.1. Arts

The existence of traditional arts tends to orientate to the development of information technology, cultural consumption, and media games of the time. The development of traditional arts is related to the meaning, function, and culture that is behind the supporting community and has the potential for the development of the tourism sector. The cultural diversity of Sekadau Regency is accommodated by the art studio. Active art studio in Sekadau Regency amounts to 19 studios spread across 7 sub-districts. The largest distribution of art studios is in Sekadau Hilir District as many as 10 studios.

Fig. 3. Art Studio Traditional Dance Performance

2.2.2. Livelihoods System

Livelihoods as a source of income for the community can have a relationship with cultural elements. Sekadau Regency area is traversed by the Kapuas River which is the longest river in Indonesia, making the lives of people who are accustomed to utilizing the river. The community uses the Kapuas River as a source of fish for fishermen, the infrastructure of river transportation equipment in the form of canoes. This transportation connects the Sekadau Hilir District area which is bounded by the Kapuas River.

Fig. 4. Water Transportation

2.2.3. Cultural Tourism Festival

Cultural festival activities play an important role as a means of communication for the development, empowerment, and recognition of cultural identity. Sekadau Hilir District as the center of the district capital is also the center of cultural festival activities carried out every year. The annual cultural festival that is routinely carried out depicts the characteristics and cultural identity of the local community, which is dominated by Dayak, Malay, and Chinese ethnic, and there is also an annual event of the Sekadau Kingdom. The diversity of existing activities makes it

clear that cultural tourism has had adequate means of communication.

(a)

(b)

Fig. 5. (a,b) Cultural Ceremony Festival

2.2.4. Palace

The Kusuma Negara Palace is a proof of the relics of the Sekadau Kingdom located in Sungai Ringin Village, Sekadau Hilir District. The existence of the Kusuma Negara Palace became a marker of the transfer of power of the Sekadau Kingdom which was previously in the Kematu area in Rawak around 1800-1830 AD, in the government of Abang Ripong Ibn Abang Kadar titled Prince Suma Negara became the leader of the Sekadau Kingdom.

Fig. 6. Kusuma Negara Palace

2.2.5. Historic Sites, Buildings and Monuments

Cultural tourism in Sekadau Hilir District has a diversity of assets and evidence of historical relics and regional characteristics. The attractions consist of: Lawang Kuari Cave, Ceromin Office, At-Taqwa Mosque, Betang Youth Center House, and Geretak Jembatan Penanjung. The existence of assets and evidence of existing historical relics have different conditions, the four objects have undergone development and pugarization, while the Ceromin Office has not been updated until now. The development of this historic object has potential if it is developed as a tourist product, and becomes a solution so that the object can be maintained

(a)

(b)

(c)

(d)

Fig. 7. Historic Sites, Buildings, and Monuments (a) Lawang Kuari Cave (b) At-Taqwa Mosque (c) Betang Youth Center House (d) Geretak Jembatan Penanjung

(a)

(b)

Fig. 8. Ceromin Office (a) Side View (b) Front View

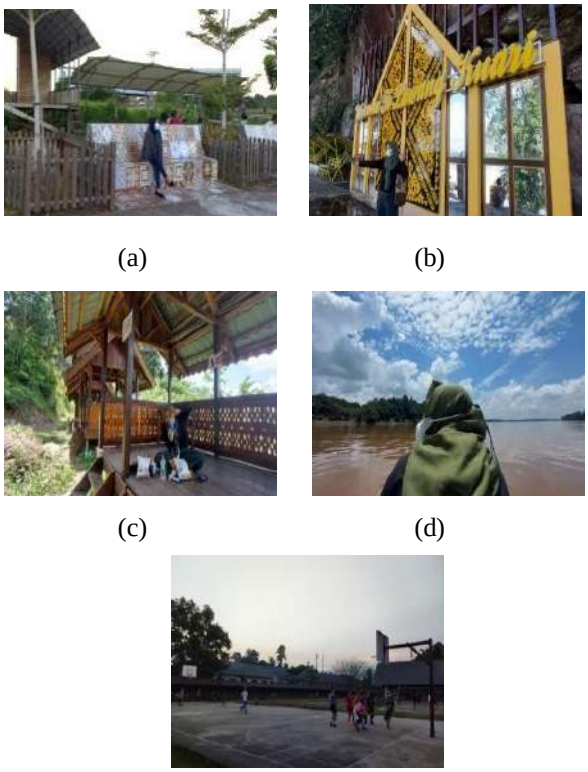
3. Results and Discussion

3.1 Cultural Attractions of Sekadau Hilir District

A. *What to do:* Activities that can be done by tourists when visiting cultural attractions in Sekadau Hilir District in the form of relaxing, taking pictures, picnics, and river stacking.

- Relaxing: Tourists can enjoy the beauty and diversity of culture in the types of tourist attractions of the livelihood system; cultural tourism festivals; palace; historical buildings and monuments in Sekadau Hilir District.
- Photographed: Many tourists deliberately come to recreation while taking a photo and video documentation.
- Picnic: Some tourists come with their families and bring food and drinks from home to enjoy when visiting the tourist attractions of Lawang Kuari Cave.
- River Stackg: One of the most desirable activities for tourists from outside the Sekadau Regency is river stacking. This activity is done by circling the river while enjoying the beautiful natural scenery. The water transport available is a speed boat

- Exercise: Community in Sekadau Hilir District often use one of the tourist attractions of Betang Youth Center House as a place to exercise in the afternoon.



(a) (b)

(c) (d)

(d)

Fig. 9. "What to Do" Tourist Attractions (a) Relaxing, (b). Photographed, (c). Picnic, (d). River Stackg, (e). Exercise.

B. *What to buy*: Tourists in Sekadau Hilir District can buy handicrafts that have cultural value in every cultural festival activity in the form of traditional clothing, traditional food and drinks, and traditional accessories. There are also other supporting facilities for MSMEs Center Sekadau Regency which sells a variety of typical sekadau hand fruits in the form of woven, food and beverages produced by communities.

C. *What to arrive*: Tourists come to cultural attractions scattered in Sekadau Hilir District with family, relatives, and acquaintances. The reason is that they want to visit this tourist attraction while while having recreation. The diversity of cultural tourism types and strategic locations in the center of Sekadau Regency makes the cultural attractions of Sekadau Hilir District is interesting to visit. There are also cultural attractions that become tourist icons in Sekadau Regency, namely Lawang Kuari Cave.

D. *What to stay*: Diversity and uniqueness of culture, and diversity of landscapes in the form of will make tourists feel at home while in cultural attractions scattered in Sekadau Hilir District. In addition, there are various kinds of supporting facilities that will lead tourists to visit various kinds of tourist attractions consisting of 14 sub-cultural attractions. The availability of supporting facilities can be a means for tourists who want to stay for some time in Sekadau Hilir District, Sekadau Regency.

Table 2. Cultural Tourism Attractions Based on The Type of Cultural Tourism

No	Types of Tourist Objects	Sub-Tourist Objects	What to see	What to do	What to buy	What to arrived	What to stay
1.	Art	- Malay Dance Studio - Dayak Dance Studio	- Traditional dance - Traditional musical instrument - Traditional clothing	- Photographed - Playing a traditional musical instrument		- Family - Acquaintance	- Cultural diversity - Cultural uniqueness
2.	*Livelihoods System*	- Water Transportation	- Canoe/Boat - River	- Relaxing - Photographed - River stacking		- Family - Acquaintance	- Landscape diversity: rivers and the forest
3.	Cultural Tourism Festival	- Temporal Cultural Festival	- Bumi Lawang Kuari Cultural Festival (FBBLK)	- Relaxing	- Traditional accessories	- Family	- Cultural diversity
		- Annual Cultural Festival	- Malay Cultural Arts Festival - Dayak Gadget Week - Customs of State Boundaries	- Photographed	- Traditional clothing - Traditional food and drinks	- Acquaintance	- Cultural uniqueness
4.	Palace	· Keraton Melayu	- Palace - Objects historical relics - King Tomb	- Relaxing - Photographed - Exercise - River stacking		- Family - Acquaintance	- Cultural diversity - Cultural uniqueness - Landscape diversity: rivers and the forest
5.	Historic Sites, Buildings, and Monuments	- Lawang Kuari Cave	- Landscapes - Historical objects	- Relaxing - Photographed - Exercise - River stacking		Family Acquaintance	- Cultural diversity - Cultural uniqueness - Landscape diversity: rivers and the forest
		- Ceromic Office	- Customs Historical relics	- Photographed			
		- At-Taqwa Mosque	- Customs Historical relics	- Relaxing - Photographed - Exercise			
		- Betang Youth Center House	- Customs Historical relics	- River stacking			
		- Penanjung Hanging Snapper	- Objects historical relics	- Relaxing - Photographed			

3.2 Cultural Tourism Facilities of Sekadau Hilir District

There are several lodging places in Sekadau Hilir District in the form of hotels and inns. Tourists can choose a place to stay according to their wants and needs during the holidays. The restaurant as a tourist supporting facility has various types spread in Sekadau Hilir District. Available restaurants are: canteens, restaurants, food courts, and others.

(a) (b)

(c) (d)

Fig. 10. Cultural Tourism Facilities (a) Lodging (b) Restaurants (c) Banks (d) Highways

3.3 Cultural Tourism Facilities of Sekadau Hilir District

3.3.1. Transportation Pathway

Accessibility from Pontianak City to cultural tourism in Sekadau Hilir District can be reached by land. The route is taken through a protocol road that connects roads between districts and cities in West Kalimantan Province. There are two (2) accessibility of land routes from Pontianak City to cultural tourism of Sekadau Hilir District, namely: (a) Pontianak – Kubu Raya – Sanggau – Sekadau, this route has a total mileage of 342.17 km with a travel time of 5-6 hours using a motor or car. (b) Pontianak – Mempawah – Landak – Sanggau – Sekadau. This route has a total mileage of 375.2 km with a travel time of 7-8 hours using a motor or car.

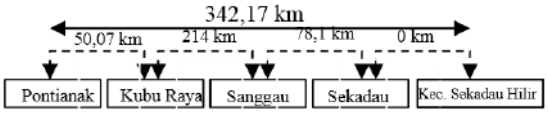


Fig. 11. Mapping Routes Through Kubu Raya

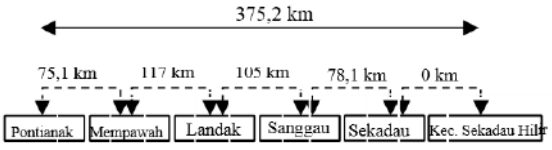


Fig. 12. Mapping Routes Through Mempawah

3.3.2. Transportation Services

Transportation services that can be accessed to go to Sekadau Hilir District include intercity public transportation (bus), taxi travel, ferry/passenger ship, and speed boat. The available transportation services can be accessed for intercity and inner-city travel of Sekadau Regency. Public Transportation (bus) has an economy ticket price for one trip from Pontianak City to Sekadau Hilir District ranging from Rp.80,000.00 to Rp.100,000.00. While the price of executive tickets ranges from Rp.140,000.00 to Rp.170,000.00. Taxi Travel for one-time ticket prices from Pontianak City to Sekadau Hilir District and vice versa is Rp.140,000.00 to Rp.170,000.00.

(a) (b)

Fig. 13. Transportation Services. (a) Bus Damri. (b) Taxi Travel

3.3.3. Interregional Transportation Facilities

Inter-regional transportation facilities are one of the supporters of tourism activities to provide travel services between districts and cities. Sekadau Hilir District has an intercity bus terminal, namely Lawang Kuari Bus Terminal. In addition, the most populous is also the steer or Kapuas River crossing pier in Sekadau Hilir District.

(a) (b)

Fig. 14. Transportation Services (a) Lawang Kuari Terminal (b) Steer/Crossing Dock

3.4 Cultural Tourism Services of Sekadau Hilir District

Ancillary (additional facilities) is an important factor that can affect the development of tourism activities. The existence of ancillary in tourist destinations will make tourists feel, safe, comfortable, and guaranteed safety. Additional services provided by institutions or authorized agencies in the area consist of regulations that support the implementation of tourist activities and the support of officers who are ready to help tourists. The additional services in question are services that must be provided by the local government, both for tourists and tourists. These additional services such as marketing, physical development and legislation (Alfitriani, 2021). Identification of ancillary conditions in Sekadau Regency is divided based on marketing, physical development, and related policies/ regulations.

3.5 Analysis of Cultural Attractions of Sekadau Hilir District

The main driving factor of the development of cultural tourism attraction objects in Sekadau Hilir District is the existence of the Sekadau Kingdom and Lawang Kuari Cave which became the forerunner of Malay development in Sekadau Hilir District and became the identity of Sekadau Regency. The existence of these two attractions will certainly facilitate in terms of cultural tourism promotion, so many tourists are interested in visiting cultural attractions in Sekadau Hilir District. In addition, the number of tourist visits and support from the local government is also one of the drivers in the development of cultural tourism in Sekadau Hilir District.

Inhibiting factors in the development of cultural tourism in Sekadau Hilir District are lack of funds, lack of promotion and lack of infrastructure and supporting facilities for tourism activities. In

addition, the lack of human resources (HR) in the field of tourism and the lack of public knowledge about tourism are also obstacles to the development of cultural tourism in Sekadau Hilir District.

4. Conclusion

Identification of cultural attractions in Sekadau Hilir District is reviewed based on the criteria for attractions, facilities, support and additional services. Based on the identification results, it is known that ODTW culture in Sekadau Hilir District can be seen as consisting of (1) art, (2) a livelihood system, (3) cultural tourism festivals, (4) palaces, and (5) historical sites, buildings and monuments. Activities that can be done by tourists during a visit to cultural attractions in Sekadau Hilir District in the form of relaxing, taking pictures, picnics, and river stacking. Something that can be purchased in the form of traditional clothing, traditional food, and drinks, as well as traditional accessories. The reason for tourist visits is based on recreation and is driven by distances that are not far away. The reason for tourists to travel at home is because of cultural diversity, cultural uniqueness, and diversity of landscapes. Based on the criteria of facilities, the facilities in Sekadau District are adequate, only the condition is not good. Based on the criteria of supporting facilities, access to cultural attractions is easy to reach because it is the district capital.

5. Author's Note

Writers declare that there is no conflict of interest regarding the publication of this article. Writers confirmed that the paper was free of plagiarism.

6. References

Alfitriani., Putri, W. A., & Ummasyroh. (2021). **Pengaruh Komponen 4A Terhadap Minat Kunjung Ulang Wisatawan Pada Destinasi Wisata Bayt Al-Qur'an Al- Akbar Kota Palembang.** JAMB (Jurnal Aplikasi Manajemen & Bisnis), 1(2): 66-77.

Astuti, P., Asteriani, F., Sofwan, M., Sardiyanto. E. (2017). **Kajian Pengembangan Wisata Budaya Kawasan Istana Gunung Sahilan Berdasarkan Persepsi Masyarakat dan Pelaku Wisata.** Riau. Seminar Nasional Space#3:409-419

Ghani, Y.A.(2017). **Pengembangan Sarana Prasarana Destinasi Pariwisata Berbasis Budaya di Jawa Barat**. Jurnal Pariwisata, Vol. IV, No. 1. Jakarta.

Marjayanti, A., Yuniarti, E., Hernoviany, R, F., 2020. **Analisis Potensi Objek Wisata Mempawah Mangrove Park Di Desa Pasir Kabupaten.** JeLAST: Jurnal PWK, Laut, Sipil, Tambang, Vol. 7, No. 1. Pontianak.

[Perda] Peraturan Daerah. (2015). **Tentang Rencana Tata Ruang Wilayah Kabupaten Sekadau Tahun 2015-2035**. Sekadau.

[Perda] Peraturan Daerah. (2016). **Tentang Rencana Pembangunan Jangka Menengah Daerah Kabupaten Sekadau Tahun 2016-2021**. Sekadau

[Perda] Peraturan Daerah. (2019). **Tentang Rencana Pembangunan Jangka Menengah Daerah Provinsi Kalimantan Barat Tahun 2018-2023**. Pontianak.

Peraturan Pemerintah. (2016). Pedoman Pemerintah Republik Indonesia tentang Pedoman Destinasi Pariwisata Berkelanjutan. Jakarta.

Profil Kecamatan Sekadau Hilir. 2020. **Buku Profil Kecamatan Sekadau Hilir Tahun 2019.** Kecamatan Sekadau Hilir.

Putri, T. A. R., Yuniarti, E., Anthy S. (2021). **Identifikasi Objek Daya Tarik Wisata (ODTW) Tama Kelempiau Kecamatan Sekadau Hilir Kabupaten Sekadau**. JeLAST: Jurnal PWK, Laut, Sipil, Tambang, Vol. 8, No. 2. Pontianak.

RIPPDA Kabupaten Sekadau. (2008). **Rencana Induk Pengembangan Pariwisata Daerah Kabupaten Sekadau Tahun 2008**. Dinas Pemuda, Olahraga dan Pariwisata Sekadau.

Susanti, S. (2015). **Kerajaan Sekadau sebagai Sumber Belajar Sejarah dalam Materi Kerajaan Islam di Indonesia**. Jurnal Ilmu Sosial, Vol.12 (1):29-39. Pontianak

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Supply and Demand Analysis of Batu Burung Beach Tourism Object In Singkawang, West Kalimantan

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Abstract

Singkawang City West Kalimantan Province has one of the natural attractions of the beach is Batu Burung Beach. The attraction of this object is the panorama of the beach with granite stones which is based on the history as the gathering place of birds. The attraction of Batu Burung Beach has not been the main destination for tourists, because it has not been developed properly and realized optimally. The factor that hinders the development of tourist attractions is marketing so that not many tourists know about the existence of this attraction. This research purposed to analyse the potential of supply and demand tourist attractions Batu Burung Beach. The research method used is quantitative method and supported by qualitative method. The analysis method that used to analyse potential supplies is ODTWA analysis, while to analyse potential demands is using descriptive analysis. The results of research on Batu Burung Beach attractions show that it is worth developing as a beach tourist destination. Based on the recapitulation of the value of potential objects and tourist attractions, the beach got a potential value index of 77.33% which falls into the category worth to be developed. The criteria that requires follow-up actions so that this object can be in priority scale and developed into a beach tourist attraction is marketing. While the potential demand criteria that require follow-up actions is the need for the expansion of tourist attraction areas, widening of the entrance, procurement of sign boards, the addition of shelters, the expansion of toilets and prayer rooms, the addition of food stalls, and the procurement of social media and information brochures. Batu Burung Beach tourism object with this handling is expected to be developed into an alternative beach tourist destination in Singkawang City.

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Identification; Tourist Attractions; Cultural Tourism; Sekadau

1. Introduction

West Kalimantan province administratively has only two cities, namely Pontianak City as the provincial capital and Singkawang City. Singkawang City is often mentioned as " Bumi Bertuah Gayung Bersambut" and "Taman Kalimantan Barat" because of the beauty of its natural landscape. One of the natural landscapes that become the main attraction of Singkawang City is its beaches. One of the beach that become tourist destinations is Batu Burung Beach which is located right next to Sinka Island Park Singkawang. It is called Batu Burung Beach from its historical story where it is a gathering place for birds to look for water on granite rocks. There are shelters available where tourists can sit and rest. Other facilities such as food stalls, prayer rooms, and toilets are also provided. There is bridge that leads to the historical bird stone and it also used by tourists or local residents to do fishing.

There are several aspects in Batu Burung Beach that need to be improved, especially in the marketing of its tourism objects. The improvements in marketing are needed as an effort to attract more visitors and improve the quality of tourist attractions that are carried out continuously and continuously (Widiastin, et al., 2012). Batu Burung Beach is managed by the government of Singkawang, therefore the marketing efforts is still lacking compared to the tourist attractions that are managed by private. The existence of the beach is not well known by tourists from other region outside Singkawang city. Tourists who visit Batu Burung Beach are mostly come from local tourists. Another aspect that may cause major impact is the environment aspect. Due to the tourist activities in the beach may cause coastal abrasion for the long term impact. The available breakwaters do not cover the entire coastal area of Batu Burung Beach. Moreover, the width of the beach is only 20 m, so it is feared that if left alone, this tourist attraction area will be lost due to abrasion.

The development of tourist attraction at Batu Burung Beach has not been carried out optimally. Therefore, in its development requires assistance and support from the government. The management of Batu

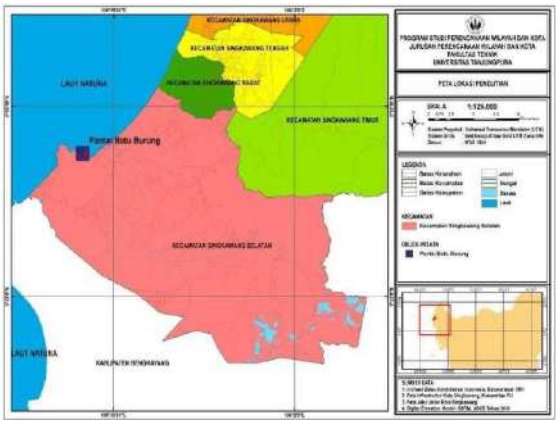
Burung Beach is still not collaborated with the government of Singkawang City. So far, the development of this tourism attraction only relies on private funds, hence the development process is very slow. Based on the description above, it is important to conduct an assessment of the potential supply to determine the feasibility of this tourism object for further development and analyse the potential demand of tourists at the Batu Burung Beach in Singkawang City, West Kalimantan.

2. Materials and Methods

2.1 Study Area

This research was conducted at the natural tourist attraction of Batu Burung Beach (Figure 1). The beach is located in Sedau Village, Singkawang City, West Kalimantan Province.

Fig..1. Study Area Map



2.2 Data

The methods used in data collection are the purposive and accidental sampling. Purposive sampling in this study is the sampling technique based on considerations in certain determinations, namely people or organizations who understand and experienced in the field are qualified to be respondents. These respondents are also called expert respondents, such as related stakeholders and managers of the beach. Meanwhile, accidental sampling determines the respondents by chance, meaning that the researcher coincidentally meets a person who is considered as a sample and is in accordance with the data source (Sugiono, 2016).

2.3 Analysis Method

The analysis methods used in this study consist of ADA-OTWA and descriptive method.

2.3.1 Potential Supply Analysis

ADO-ODTWA analysis is used to process data and information related to the existing tourism potential. This analysis is used to examine and calculate the development criteria that have been determined in structured steps so that a priority scale for the development of the tourism object is obtained. Meanwhile, to assess elements and sub-elements in the criteria, were obtained from the existing condition of the tourism object. These criteria are analysed based on current condition of the beach and combined with the priority of data that are suitable for this research. The criteria used in this research are tourist attraction, accessibility, management and services, accommodation, supporting facilities and infrastructure, availability of clean water, security, and marketing (Directorate General of PHKA, 2003). The next analysis step was to sum up all of the criteria that have been assessed.

The calculations of tourist attractions value are carried out to obtain the potential value of a tourism object, while the weight of each object has been determined for each element and is used to obtain the total score of the tourism object. The total score was obtained after the weight of each criterion is multiplied by the sum of the scores in each element (Romani, 2006).

$$S = N \times B \quad \text{.....(1)}$$

Description:

S = Score

N = Total value of elements with criteria

B = Weight of value

Each criterion of potential and tourist attraction consists of low, medium, and high to classify the development level. The interval for each development classification was obtained by subtracting the highest score from the lowest score and then dividing the result with the interval used (Oktadiyani, 2006).

$$Interval = (Smax\text{-}Smin)/K \quad \text{.....(2)}$$

Description:

Interval = Interval value

Smaks = The highest score

Smin = The lowest score

K = Number of development classifications

From this step, a feasibility index was obtained to decide which tourist object that will be a prioritized for development (Karsudi, et al., 2010). The feasibility index rates are divided as:

Feasibility rate > 66.6% = Feasible for development

Feasibility rate 33.3% - 66.6% = Not yet feasible for development

Feasibility rate < 33.3% = Not feasible for development

The feasibility rate is used to determine the classification of tourism object development. If the assessment result shows that Batu Burung Beach is included as feasible area to be developed, then it will be recommended to be a priority in the preparation for tourism development.

2.3.2 Potential Demand Analysis

Data and information for potential demand were collected from tourists using a questionnaire. The variables used are socio-economic, tourist opinions,

and tourist behaviour or motivation. The information that were obtained from tourists are tourist characteristics, tourist travel patterns, tourist motivation, tourist ratings, tourist expectations, and the frequency of tourist visits. From the data, a recapitulation will be carried out to gain conclusions from the demand that will be used to generate development recommendations. Thus, the development recommendations are the final result of supply analysis, demand analysis, and inputs from the manager of Batu Burung Beach.

The data and information collected from tourists will be analysed using descriptive method. This method is one of the statistical methods for data processing, starting from data collection, summarizing, presenting, to describing data until the final data and information result is summarized (Nisfisiannoor, 2009).

3. Result and Discussion

3.1 Potential Supply Analysis

The basis for potential supply assessment in this study consists of eight criteria, including elements and sub elements which assessed in accordance with the existing conditions at Batu Burung Beach.

3.1.1 Attractiveness

The attractiveness of tourism object is assessed by calculating seven elements. Based on the results of the calculation, a total score of 900 was obtained for the attractiveness value, which means it includes in moderate category (Table 1).

Batu Burung Beach has various beauty attractions including views to the islands and hills in the sea, beautiful and clean beaches, as well as harmonious.

Table 1. Attractiveness of Batu Burung Beach

No	Elements/Sub elements	Value
1	Beauty	25
2	Safety	30
3	Colors and types of sand	25
4	Variations of activities	25
5	Cleanliness	15
6	Width of beach	10
7	Comfort	20
	Total	**150**
	Total score (score x value (6))	**900**

views of the beach and its surroundings. Tourist safety is also guaranteed because the beach is located in non-toxic and no escarpment area. The beach is close to settlements, hence there is influence from settlements and livestock of the surrounding community. In addition, the name of Batu Burung Beach itself is unique, which came from the local story said that many birds perched on a big rock at beach to drink (Figure 2).

Fig. 2. Natural landscape of Batu Burung Beach

3.1.2 Accessibility

Accessibility is related to the ease of access, meaning the ease of getting to a place and connectivity to other places. Accessibility is crucial for the development of a tourist object because both of transportation modes and roads provide easy access to the tourist object. Tourists might cancel their visit if the tourist object has poor accessibility. In this case, a good accessibility and connectivity also become one of the consideration for a tourist to visit (Yuniarti, *et al*., 2018).

Accessibility was assessed by calculating two elements. This calculation resulting a total score of 400 which means it is included in the high category (Table 2). This shows that the accessibility of this tourism object is well developed.

Table 2. Accessibility to Batu Burung Beach

No	Elements/Sub elements	Value
1	Road condition and distance from the provincial capital	60
2	Travel time	20
	Total	**80**
	Total score (score x value (5))	**400**

Batu Burung Beach and Sinka Island Park are located side by side. There is a connecting access to Sinka Island Park which takes only five minutes by vehicles from Batu Burung Beach. Meanwhile, it takes approximately thirty minutes to get to nearby beaches such as Pasir Panjang Indah Park, Palm Beach, Tanjung Bajau, and Air Merah Beach. The roads are mainly in sufficient condition covered with asphalt pavement and paving blocks.

3.1.3 Management and Service

Management and services are assessed by counting three elements that are included in high category with a total score of 280 (Table 3).

Table 3. Management and service in Batu Burung Beach

No	Elements/Sub elements	Value
1	Management	25
2	Language skill	15
3	Service	30
	Total	**70**
Total score (score x value (4))		**280**

The management of tourism objects and its services needs to be maintained and improved as it directly affects the preservation of tourist objects and the most important thing is that it affects visitor satisfaction. Good management of tourist objects and services can be achieved by improving professional staff and communication skills. The hospitality, availability, and ability to guide tourists reflect the services provided by the manager and the surrounding community.

One of the important points in providing services is to establish communication with tourists to be able to convey information about the tourist object. Unfortunately, language often become the barrier to communicate, especially to foreign tourists. Manager and staff who operate the tourist object mostly speak only in Indonesian or local language, thus they cannot make good conversation with foreign tourists.

3.1.4 Accommodation

Accommodation is assessed by calculating the element number of rooms, from nearby accommodation. Accommodation plays an important role in supporting tourism objects. The accommodation distance to the tourism objects must be within a radius of 15 km. The calculation result obtained a total score of 90 which include in high category (Table 4). The high score was gained from the location of hotels that are close to Batu Burung Beach.

Table 4. Accommodation of Batu Burung Beach

No	Elements/Sub elements	Value
1	Number of rooms	60
	Total	**80**
Total score (score x value (5))		**400**

The nearby popular hotels are Mahkota Hotel and Swiss Belinn which has a capacity of more than 100 rooms. The more developed an area of a tourism object will always be followed with an increase in the accommodation quality and the construction of new settlements (Wibowo and Ma'arif, 2014).

3.1.5 Facilities and Infrastructure

Attractions offered by a tourism object is not the only thing that attracts tourists. The availability of supporting facilities and infrastructure is very necessary to provide comfort for tourists during their visit. Comfortable facilities and sufficient infrastructure also give a good impact on the tourism object itself. The availability of facilities and infrastructure is assessed by calculating two elements. The first element is facilities and the second is infrastructure. The calculation results are included in the high category with a total score of 165 (Table 5).

Facilities are directly used by tourists to enjoy existing tourism objects. Meanwhile, infrastructure indirectly allows tourists to benefit from the tourism objects. The level of interest to a tourism object can affect the availability of facilities offered (Vengesayi, 2003). Some of the facilities and infrastructure that have been built at Batu Burung Beach are food and beverage stalls, toilet, prayer rooms, shelters, entrance and pathways, parking areas, electricity networks, drinking water networks, waste disposal, and information boards

Table 5. Facilities and infrastructure assessment

No	Elements/Sub elements	Value
1	Facilities	25
2	Infrastructure	30
	Total	**55**
Total score (score x value (3))		**165**

3.1.6 Availability of Clean Water

The availability of clean water is assessed by calculating the five elements resulting a total score of 840 which included in high category (Table 6). Batu Burung Beach is equipped with adequate clean water facilities. The clean water flows directly through pipes from mountain springs which located not far from the beach. The quality of the water is very clear and used for consumption by the surrounding community by cooking it. The water is available all year round. The preservation of vegetation around the springs is one of the main factors to maintain the clean water quality and availability.

Table 6. Clean water availability

No	Elements/Sub elements	Value
1	Volume	30
2	Distance from source	25
3	Distribution piping	30
4	Eligibility for consumption	25
5	Availability	30
	Total	**145**
Total score (score x value (6))		**840**

3.1.7 Security

Security can be assessed by calculating four elements resulting a total score of 425 which means it is included in the moderate category (Table 7). Security is related to the protection for tourists so they feel comfortable and protected while visiting the tourism object. The security of in Batu Burung Beach is still lacking due to disturbance from livestock that come from nearby settlements. In addition, fire incidents also occurred around the beach. The fire was indicated to be caused by natural factors, but the exact cause was still unknown. Until recently, tree felling has only been carried out by the surrounding community for personal purpose.

Table 7. Security assessment

No	Elements/Sub elements	Value
1	Tourist safety	25
2	Wildfire	25
3	Illegal logging	30
4	Land use	5
	Total	**85**
	Total score (score x value (5))	**425**

3.1.8 Marketing

The assessment of marketing is based on marketing criteria. The total score of 60 shows that it is in the medium category (Table 8). One of the determinants of tourism objects development is its marketing. The increase in tourist visits can also be influenced by good tourism promotion. Batu Burung Beach still need to intensify the promotion effort since only few people know about the existence of this tourist object. The entrance fee to Batu Burung Beach is free. Visitors only need to pay Rp. 5,000 for motorbike parking and Rp. 10,000 for car parking

Table 8. Marketing of Batu Burung Beach

No	Elements/Sub elements	Value
1	Marketing	15
	Total	**15**
	Total score (score x value (4))	**60**

3.1.9 Potential Supply Recapitulation of Batu Burung Beach

The assessment of all the criteria must meet all the elements that are taken into account as the initial assessment. The assessment of overall criteria resulting a final index of > 77.83%, it means that Batu Burung Beach is feasible to be further developed. Meanwhile, the lowest potential index value is gained by the marketing component with 50 score which falls in the range of > 33.3% - 66.6%, meaning that this criterion is not feasible to be developed (Table 9). Therefore, managers should optimize the dissemination of information or advertisements through various media, both print media and social media and other electronic media to increase the number of visits.

3.2 Potential Demand Analysis

The assessment of potential demand is carried out by analysing three parameters, namely: attitudes, tourist behaviour, and tourist ratings to the tourist object. This analysis method is known as ODTWA analysis, used to determine the existing potential and problems seen from the point of view of tourists. The needs of tourists during their visit is determined from this analysis.

3.2.1. Tourist Characteristics

The survey results for tourist characteristics found that the tourists consist of 71% men and 29% women. The average age of tourists is 11-20 years old for men and 21-30 years old for women. This age range is the age where people are more productive to do various activities, including traveling. The majority of tourists are from Singkawang City with by 86%, and others are from Pontianak City by 14%. This means that the travel distance also effects on tourist visits. The less travel distance and travel time, the more people interested to visit a tourist object.

Another determining factors is the ease of access to Batu Burung Beach, shown by the good condition of roads that already covered by asphalt. The only area that still covered by paving block is the entrance to the beach. The majority of tourists are students by 86% and 14% as private employees. Marital status shows that 86% are married and 14% are single. The tourists with income value > 500,000 are more dominant by 86%. This shows that low budget tourist objects, especially those with free entrance fee, are still very popular among tourists. Vice versa, tourism objects that offers many attractions but the ticket prices are expensive are tend not to be very popular among tourists as it only attracts tourists with high income.

Table 9. Marketing of Batu Burung Beach

No	Criteria	Value	Total score	Potential Value	Maximum value	Potential index value (%)	Feasibility Index
1	Attraction	6	150	900	1260	71.43	Feasible
2	Accessibility	5	80	400	550	72.73	Feasible
3	Management and service	4	70	280	360	77.78	Feasible
4	Accommodation	3	30	90	90	100.00	Feasible
5	Facilities and infrastructure	3	55	165	180	91.67	Feasible
6	Availability of clean water	6	140	840	900	93.33	Feasible
7	Security	5	85	425	600	70.83	Feasible
8	Marketing	4	15	60	120	50.00	Not feasible
	Jumlah		**625**	**3160**	**4060**	**77.83**	**Feasible**

3.2.2. Tourist Pattern

To analyse tourist pattern, the parameters are reason for visit, type of visit, transportation mode used, and source of information. The survey results show that tourists who planned their visit ahead by 57%. Tourists who visited in groups by 57%, by oneself 14%, and couple by 29%. Meanwhile, the majority of transportation mode used consists of motorcycles by

86%. The main source of information for tourists about Batu Burung Beach is from word of mouth by 86%. The results of this pattern of tourists indicate that the manager must provide all the necessary facilities to meet all the needs of tourists, such as shelters and places to eat and drink. Increasing the quality and quantity of new and unique attractions is necessary to make the tourists visiting again. The provision of facilities, especially for private vehicles, is also needed so that tourists feel safe and comfortable bringing private vehicles considering that there is no public transportation to get there. Dissemination of information is also needed, apart from word of mouth, promotions need to be enhanced through other media.

3.2.3. Tourist Motivation

Tourists can be interpreted as people or individuals who do recreation by visiting tourism objects (Goeldner and Ritchi, 2000). Tourist motivations can vary. A person's need or desire to be free from routine activities will form the motivation for tourism. Curiosity about a tourist objects that arises from tourists is caused by their motivation to travel (Athman and Monroe, 2004). The reasons for visits and activities are the motivational parameters of tourists. Based on this calculations, it is known that most tourists go on vacation for relaxation or to relieve fatigue indicated by 71%. While the activities carried out by tourists are intended to avoid themselves from routine activities which are indicated by 86%.

3.2.4 Tourist Rating

Tourists rating can be interpreted as tourist opinion about the condition and development of Batu Burung Beach. The tourists rating assessment consists of 5 aspects, namely: a). Aspects of attractiveness (addition of attractions, arrangement of the area, cleanliness of tourist objects, and safety of tourists), b). Aspects of accessibility (roads condition and directions), c). Aspects of supporting facilities (shelters, toilets, prayer rooms, gardens, parking lots, food stalls, souvenir shops, lodging, information boards, information centers, and clean water supply), d). Marketing aspects (social media and information brochures), e). Security aspects (security posts, security guards, and safety facilities).

3.3 Tourism Object Development

Batu Burung Beach has a potential value index of 77.83%, which means that this tourism object is feasible for further development. The development recommendations given are combination of the results of supply analysis, demand analysis and inputs from beach managers (interviews result) which are then classified according to the tourist assessment. The development to increase tourism potential in tourist objects is expected to achieve better tourism quality, increase on the number of visits, and positive impacts on the economy of the surrounding communities (Hidayat, 2011).

The agenda of tourism object development includes: increasing supporting facilities and infrastructure inside and outside the area, increasing accessibility to and from the tourism object area, as well as vigorous promotion and management.

3.3.1 Results of Potential Supply Analysis

The tourism supply consists of seven components, namely attractions, costs spent by tourists, accessibility, facilities, service, activities offered, and marketing (Kresic and Prebezac, 2011). The tourism supply components are in accordance with the criteria for assessing the potential supply of Batu Burung Beach. The potential attractions for Batu Burung Beach are: a). Panorama of the island on the sea, b). There is a uniqueness, namely Batu Burung which is the icon of Batu Burung Beach, c). Various activities that can be enjoyed such as: swimming, fishing, boating, d). Suitable for fishing, e). Noise free, f). No impact from pollutants and waste, g). Clean water supply from the springs. h). Free entry

3.3.2 Results of Potential Demand Analysis

The inputs and suggestions from tourists play an important role in the development of a tourism object. It is interpreted as requests or demand by tourists in order to improve the quality of the tourist object. This quality improvement is performed in the form of procurement of attractions and new infrastructure as well as maintenance of existing infrastructure. The inputs and suggestions collected from the survey are such as, improving facilities, improving accessibility, and improving the cleanliness of tourism objects. All inputs and suggestions from tourists should be taken into account and correspond with sustainable tourism by preserving the natural environment of the beach.

The facilities required by tourists are: a). Expansion of tourist attraction area, b). Widening the entrance area, c). Procurement of sign boards, d). Addition of shelters, e). Expansion of toilets and prayer rooms, f). Addition of food stalls, g). Promotion by social media and information brochures.

The development of tourism objects needs to be done by the management team together with support from the government. The government can promote or further introduce the tourism potential of Singkawang City by holding annual routine activities such as festivals, exhibitions, Singkawang City Government Anniversary events, and sports tournaments. Promotion can also be done through print media such as: banners, billboards, billboards, pamphlets, and brochures. In addition, it can also be done by optimizing the function of the tourism ambassador of Singkawang City and the tourism communities in Singkawang City. Another active role of the government is to encourage culinary and hotel entrepreneurs in Singkawang City to always improve the quality of services.

The management team of the tourism objects need to improve the marketing, especially tourism promotion. It is expected that the potential of Batu Burung Beach

tourism object can be developed optimally so that it can increase tourists interest. With the increase in the number of tourists, it will also give positive impacts on improving the welfare of the surrounding community.

4. Conclusion

Eight criteria assessment were carried out based on the results of supply potential analysis. The assessment results show that seven criteria have feasibility index rate of >66.6%, meaning that it is feasible to be developed and only marketing that have feasibility index rate of 33.3%-66.6%, which is not feasible to be developed. The tourism potential of Batu Burung Beach has a total index value 77.83%, which means that Batu Burung Beach is feasible to be developed by improving the marketing criteria. The assessment of potential supply analysis shows that the criteria for attractiveness, accessibility, service management, infrastructure, availability of clean water, accommodation, and security of Batu Burung Beach are in high score which represent the criteria are well developed. While the marketing criteria receive a moderate score because it relates to the dissemination of information and promotions that is still lacking.

The results of the potential demand analysis show that the tourists expect an expansion of the tourism object area, widening of the entrance area, procurement of sign boards, addition of shelters, expansion of toilets and prayer rooms, addition of food stalls, as well as promotion by social media and information brochures.

5. Author's Note

Writers declare that there is no conflict of interest regarding the publication of this article. Writers confirmed that the paper was free of plagiarism.

6. References

Athman, J. dan Monroe, M. (2004). **The effects environment based education on student achievement motivation.** Journal of Interpretation. Vol. 9, No. 1: 9 –25

[Dirjen PHKA]. (2003). **Direktorat Wisata Alam dan Pemanfaatan Jasa Lingkungan Direktorat Jendral Perlindungan Hutan dan Konservasi Alam Departemen Kehutanan. Pedoman Analisis Daerah Operasi Objek dan Daya Tarik Wisata Alam (ADO -ODTWA).**

Goeldner, C. R., Ritchi, J. R. B. (2000). **Tourism: Principles, Practices, Philosophies.** New Jersey: John Wiley & Son, Inc.: 5.

Hidayat, M. (2011). **Strategi Perencanaan Dan Pengembangan Objek Wisata (Studi Kasus Pantai Pangandaran Kabupaten Ciamis Jawa Barat).** Tourism and Hospitality Essentials (THE) Journal. Vol. 8, No. 1: 33- 44.

Karsudi., Soekmadi R., Kartodihardjo H. (2010). **Strategi pengembangan ekowisata di Kabupaten Kepulauan Yapen Provinsi Papua**. Jurnal Manajemen Hutan Tropika XVI. Vol. 16, No. 3: 148- 154

Krešić, D., Prebezac, D. (2011). **Index of Destination Attractiveness as a Tool for Destination Attractiveness Assessment. TOURISM** - An International Interdisciplinary Journal. Vol. 59, No.4: 497 – 517

Nisfisiannoor, M. (2009). **Pendekatan Statistika Modern**. Jakarta: Salemba Humaniaka

Oktadiyani, P. (2006). **Alternatif Strategi Pengelolaan Taman Wisata Alam Kawah Kamojang, Kabupaten Bandung Provinsi Jawa Barat**. Fakultas Kehutanan Institut Pertanian Bogor.

Romani, S. (2006). **Penilaian Potensi Objek dan Daya Tarik Wisata Alam Serta Alternatif Perencanaannya di Taman Nasional Bukit Duabelas Provinsi Jambi**. Fakultas Kehutanan Institut Pertanian Bogor.

Sugiyono. (2016). **Metode Penelitian Kuantitatif, Kualitatif dan R&D**. Bandung: Alfabeta

Vengesayi, S. (2003). **A conceptual model of tourism destination competitiveness and attractiveness.** Anzmac: Conference proceedings; Des 1 -3; Adelaide. Australia

Wibowo, P. A. S., Ma' rif, S. (2014). **Alternatif Strategi Pengembangan Desa Rahtawu Sebagai Daya Tarik Wisata di Kabupaten Kudus**. Jurnal Wilayah dan Lingkungan. Vol. 2, No. 3: 245- 256

Widiastin, N. M. A., Andiani, N. D., Trianasari. (2012). **Strategi Pemasaran Pariwisata di Kabupaten Buleleng, Bali**. Jurnal Ilmu Sosial dan Humaniora. Vol. 1, No. 10: 1 –19

Yuniarti, E., Soekmadi, R., Arifin, H. S., Noorachmat, B. P. (2018). **Analisis Potensi Ekowisata Heart of Borneo di Taman Nasional Betung Karihun dan Danau Sentarum Kabupaten Kapuas Hulu**. Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan. Vol. 8, No. 1: 44- 54

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Analysis Of Base Subsectors And Leading Agricultural Commodities In Sekadau Regency, West Kalimantan Province

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Abstract

The contribution of agriculture which has increased each year has been encouraged to be a strategic area for the economic development of Sekadau Regency. However, weakness of planning policy, insufficient quantity, and quality of infrastructure are obstacles to developing strategic areas. This study aims to analyze the basis of sub-sectors and leading commodities of agriculture in Sekadau Regency. The research approach used an exploratory qualitative with descriptive analysis methods to get an overview of agricultural productivity and Location Quotient Analysis, Shift-Share Analysis, and Klassen Typology to get the leading commodities of agriculture. The results of the study show that the productivity level of the agricultural sub-sector in Sekadau Regency is quite diverse. The agricultural and progressive sub-sector in Sekadau Regency is owned by food crops and plantations. Furthermore, the leading commodities of the food crop sub-sector in Sekadau Regency are corn, rice, and sweet potatoes. The main commodities of plantation sub-sectors in Sekadau Regency are pepper, rubber, and oil palm.

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1. Introduction

The challenges of economic development in the decentralization era require each region to be able to have high competitiveness, inside and outside the region. This encourages each region to accelerate economic development in a focused manner through the development of priority products to be able to compete in the free market, especially in its region (Directorate of Special and Disadvantaged Zone Development, 2003). The agricultural sector in regional economic development is one of the important sectors to prosper the community (Jhingan M.L. 2012). Development policies are directed so that agriculture can become a resilient sector, in the short term able to face economic crises, and in the long run able to face globalization with a sustainable agricultural system, a democratic economic system, and a decentralized government (Sumodiningrat, G. 2000).

There are 6 (six) key factors in determining a superior commodity for an area, including the amount of added value of output, the high content of domestic inputs, export specialization, the amount of output investment, distribution, sensitivity, and high contribution of GDP (Ningsih, E. S. M. 2010).

Based on previous research, the economic sector of Sekadau Regency that is growing rapidly and can be prioritized for development is the agricultural sector. The development of the agricultural sector is expected to absorb a very large workforce so that it can reduce the unemployment rate (Harsono, Bayu D., 2012). Sekadau urban areas, especially Sekadau Hilir District tend to advance faster than other sub-districts. The limitations of the infrastructure of the northern region of Sekadau, especially land transportation facilities and infrastructure, can increase the prices of superior commodities from the region so that it can less compete in the market. In addition, the vast area of water supported by the Sekadau Rivers and Belitang Rivers makes some areas vulnerable to standing water and flooding. Tidal conditions of rivers can affect agricultural productivity, making it difficult for residents to move.

The above problems are a challenge in developing agricultural superior commodities in Sekadau Regency. Thus, there is a need for research related to the analysis of base subsectors and agricultural superior commodities in Sekadau Regency. Thus, local governments can formulate focused and integrated development concepts, specially oriented to local characteristics and regional development capabilities.

2. Materials and Methods

2.1 Research Significance

This research aims to analyze the subsectors of agricultural bases and commodities in Sekadau Regency. This can be achieved by identifying the agricultural productivity of Sekadau Regency and analyzing the opportunities of the superior agricultural commodities of Sekadau Regency to the regional region, namely West Kalimantan Province. Thus, the research output is expected to provide recommendations for the regional government in

preparing agricultural development policies and improving the economy of the Sekadau Regency area.

2.2 Study Area

Sekadau Regency is one of the districts in West Kalimantan Province which has an area of 5,444.30 km² and consists of 7 sub-districts and 87 villages. Administratively the boundaries of Sekadau Regency are as follows:

a. The North is bordered by Sintang Regency;
b. The Southside is bordered by Ketapang Regency;
c. The Eastside is bordered by Sintang Regency;

The Westside is bordered by Sanggau Regency

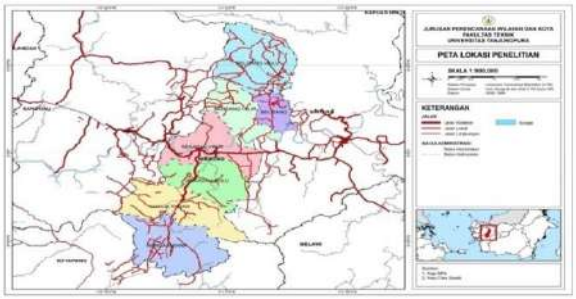

Fig.1 Map of Sekadau Regency

2.3 Data

The form of data in this study consists of primary and secondary data. Primary data collection is obtained by making direct observations of several agricultural mainstay areas in Sekadau Regency. In addition, data collection was also obtained through interviews with key informants, namely farmers and representatives of the Agriculture Office and BAPPEDA sekadau regency to get in-depth information. As for the collection of secondary data obtained from literature studies, some previous research, and agricultural development policies of Sekadau Regency.

2.4 Analysis Method

Analytical techniques applied to determine the superior commodities in Sekadau Regency are Location Quotient (LQ), Shift-share, and Klassen Typology. The Location Quotient (LQ) Method is an index to compare the share of a region or the aggregate phenomenon of LQ can be used to determine the concentration and or spread of production activities in one region (Putri, et al., 2020). LQ is used to describe the comparative advantages of the production of a commodity in a given region (Rudiantho, S. J., 2012.)

$$LQ = \frac{Ri/Rt}{Ni/Nt} \quad \text{.....(1)}$$

Ri = Production of subsectors/commodities i of Sekadau Regency

Rt = Production of subsectors / total commodities of Sekadau Regency

Ni = Production of subsectors /commodities i of West Kalimantan Province

Nt = Total subsector/commodity production of West Kalimantan Province

The LQ value used in this study is as follows:

- LQ value > 1, commodities are base commodities in Sekadau Regency and can be further developed.
- LQ value < 1, commodities are non-base commodities in Sekadau Regency and are not progressive to be further developed.
- Value LQ = 1, commodities are commodities in Sekadau Regency that have the same growth rate as West Kalimantan Province.

Furthermore, calculations are carried out using Sift Share Analysis (SSA) which is an analytical technique to see the economic structure of a sector share of a region or location concerning the wider region. This technique is very useful for analyzing changes in the structure of the local economy and its relation to regional economies (Ryolla, Z. Q et al., 2018)

PPW = $ri(ri'/nt - nt'/nt)$

PP = $nt(nt'/nt - Nt/nt)$ .....(2)

PB = PPW+PP

PPW = Region Share Growth

PP = Proportional Growth

PB = Net Growth

ri = Commodity production i of Sekadau Regency early years

ri' = Commodity production i of Sekadau Regency final year

nt = Commodity production i of West Kalimantan Province early years

nt' = Commodity production i of West Kalimantan Province final year

NT = Total production of West Kalimantan Province in the early years

NT' = Total production of West Kalimantan Province for the final year

Result description:

PP > 0	Commodities i have rapid growth
PP < 0	Commodities i have slow growth
PPW > 0	Commodities i have good competitiveness
PPW < 0	Commodities i have less good competitiveness
PB ≥ 0	Commodity growth i including progressive group (advanced)
PB < 0	Commodity growth i including sluggish group

Next, Klassen Typology is a regional economic analysis tool that can be used to determine the classification of regional economic sectors. The determination of commodity quadrants is adjusted to the results of LQ and Shift-share analysis calculations. The value of LQ and Net Growth (PB) in each commodity is used as a determinant of the commodity

class. Klassen typology analysis produces four classifications of sectors with different characteristics (Sjafrizal, 2008).

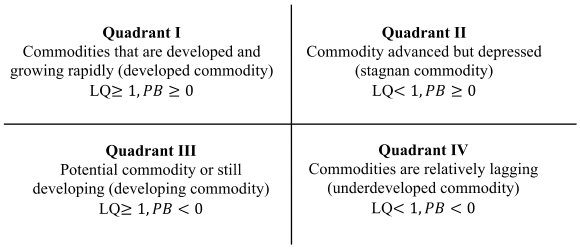

Fig.2 Matrix of Klassen Typology

3. Result and Discussion

The contribution of the economic sector to the Gross Regional Domestic Product (GRDP) of Sekadau Regency from 2016 to 2020 was dominated by the agricultural sector. The largest role in the economic structure of Sekadau Regency in 2020 was produced by the Agriculture, Forestry, and Fisheries business field, which was 39.77 percent where this figure increased from 37.98 percent in 2016 (Central Statistics Agency, 2021). Before analyzing the superior agricultural commodities of Sekadau Regency, first, analyze the basic agricultural subsector that has the opportunity to be developed using Location Quotient (LQ) analysis techniques. This analysis uses a comparison of the number of agricultural subsector productions of West Kalimantan Province and the amount of production of the agricultural subsector of Sekadau Regency in 2016 - 2020. Agricultural production in West Kalimantan Province grew from 2016 to 2019 but declined in 2020. The livestock subsector has the largest amount of production in West Kalimantan province and varied growth rates.

Agricultural production in Sekadau Regency has experienced mixed growth over the past 5 years. From 2016 - to 2020, the livestock subsector has a relatively increasing production rate every year. 2017 recorded the highest production figure of 1,484,269 heads, an increase from 2016 of 1,300,950 heads. The agricultural subsector of Sekadau Regency's food crops has an increasing amount of production every year. But it occupies the second-lowest production figure after the fisheries subsector of 5 agricultural subsectors in Sekadau Regency. The plantation subsector also has a variety of production numbers, an increase began to be seen from 2016 of 199,443.10 tons until 2019 of 323,135,756 tons but decreased in 2020 to 262,769 tons. The horticulture subsector also has a varied amount of production, an increase began to be seen from 2016 of 97,032.86 tons until 2019 of 413,255.43 tons but decreased in 2020 to 11,726.45 tons.

Table 1. Results of Location Quotient (LQ) Analysis of Sekadau Regency Agricultural Subsector, 2016 – 2020

Agricultural Subsector	Year					Average	Results
	2016	2017	2018	2019	2020		
Food Crops	0,84	0,8	1,45	1,5	1,59	1,31	Base
Horticulture	1,95	2,31	5,96	5,12	0,15	3,2	Base
Plantation	3,55	3,13	2,53	2,61	2,1	2,68	Base
Farm	0,88	0,87	0,75	0,71	0,94	0,82	Non-Base
Fishing	0,21	0,43	0,78	0,75	0,33	0,53	Non-Base

Based on the results of the analysis, the base subsector with an LQ value of > 1 in Sekadau Regency is owned by the horticulture subsector, the plantation subsector, and the agricultural subsector of food crops. These three base subsectors have the opportunity to export their sales and are quite contributing to the growth of agricultural production in the West Kalimantan Province region. The horticulture agriculture subsector became the basis from 2016 to 2019 with the highest average LQ value of the other subsectors, which was 3.20. The plantation subsector showed a consistent LQ > 1 value from 2016 to 2020 with an average LQ value of 2.68. The food crop subsector has an LQ value of > 1 from 2018 to 2020 with an average LQ value of 1.31. The livestock and fisheries subsector over the past 5 years showed that the LQ value < 1 so these two subsectors did not qualify as base agricultural subsectors in Sekadau Regency.

Table 2. Results of Shift-Share Analysis (SSA) of Sekadau Regency Agricultural Subsector, 2016 - 2020

Agricultural Subsector	Proportional Growth (PP)	Region Share Growth (PPW)	Net Growth (PB)	Shift-Share Analysis
Food Crops	-0,24	0,77	0,53	Progressive
Horticulture	0,47	-1,25	-0,77	Sluggish
Plantation	1,06	-0,63	0,42	Progressive
Farm	-0,05	0,19	0,14	Progressive
Fishing	-0,09	0,67	0,58	Progressive

Based on the results of shift-share analysis, there are 4 agricultural subsectors of Sekadau Regency that have a PB value of > 0 and belong to progressive groups, namely subsectors of food crops, plantations, livestock, and fisheries. The subsector of food crops, livestock, and fisheries of Sekadau Regency have a PP value of < 0 which indicates slow growth, but the value of PPW > 0 is well competitive and the Net Growth (PB) value > 0 including progressive groups. The plantation subsector has a PP value of > 0 for rapid growth, but the value of PPW < 0 has poor competitiveness, and the PB value > 0 includes progressive groups. Horticulture subsector, PP value > 0 indicates rapid growth, PPW value < 0 has poor competitiveness and Net Growth (PB) value < 0 including sluggish group.

The results of the Location Quotient (LQ) analysis of the base subsector with an LQ value of > 1 in Sekadau Regency are owned by 3 subsectors, namely horticulture, plantations, and food crops. The results of Shift-Share Analysis, there are 4 agricultural subsectors of Sekadau Regency that have a PB value

of > 0 and belong to a progressive group, namely the subsector of food crops, plantations, livestock, and fisheries. Based on the results of both analyses that have been carried out, the basic and progressive agricultural subsectors in Sekadau Regency are owned by food crops and plantations.

After analyzing the base agricultural subsector in Sekadau Regency, the next step is to analyze the superior commodities in the two base subsectors in Sekadau Regency. This analysis uses three analytical techniques, namely Location Quotient (LQ), Shift-Share Analysis (SSA), and Klassen typology. First, the Location Quotient (LQ) analysis was carried out by comparing the total production of food crops and plantations in Sekadau Regency and West Kalimantan Province. The data used is in the form of data on the production of the harvest of the two subsectors (tons) in Sekadau Regency and West Kalimantan Province from 2016 to 2020. Each amount of subsector production in the district is compared to the total production in the district, as well as the amount of production at the provincial level. The result will determine the base value of each commodity subsector of food crops and plantations.

Table 3. Results of Location Quotient (LQ) Analysis of Food Crops and Plantation Commodities of Sekadau Regency, 2016 - 2020

Agricultural Commodities	Year					Average	Results
	2016	2017	2018	2019	2020		
Food Crops							
Rice	0,86	1,04	1,02	0,94	0,83	0,9	Non-Base
Corn	0,26	0,47	1,17	2,55	3,38	1,6	Base
Yam	2,6	1,18	0,71	0,33	0,36	1	Base
Plantation							
Deep Coconut	0	0	0	0	0	0	Non-Base
Cacao	0,12	0,22	0,36	0,35	0,52	0,3	Non-Base
Pepper	0,02	0,15	0,18	0,17	0,17	0,1	Non-Base
Coffee	0	0	0	0	0	0	Non-Base
Rubber	1,02	1,01	1,28	1,2	1,5	1,2	Base
Oil palm	1	1	0,98	0,99	0,99	1	Base

The basic commodities of the food crop subsector in Sekadau Regency are corn and sweet potatoes. Corn commodities have an LQ value of > 1 as a food crop base commodity with an average LQ value of 1.6. Corn became a base commodity in Sekadau Regency starting in 2018 with an LQ value of 1.17 and increasing to 3.38 in 2020. The yam commodity also has a fairly high production and becomes a second base commodity by showing an average LQ value of 1.0. Ubi has an LQ value of > 1 as a base commodity in 2016 of 2.6 and 2017 of 1.18. However, the LQ value has decreased to non-base starting in 2018 with a value of 0.98 to 0.99 in 2020. Based on these values, it can be seen that the production of sweet potatoes is promising enough to be developed as well as a commodity for the agricultural base of food crops. Rice became a base commodity in 2017 and 2018 with LQ values of 1.04 and 1.02, respectively. However, the LQ value decreased to non-base from 2019 by 0.94 and in 2020 by 0.83. Judging from the average value, rice shows an LQ value of 0.9 to be a non-base commodity in Sekadau Regency.

Second, Shift-share Analysis is carried out to show proportional growth, growth of regional share, and net growth of each food crop commodity and plantation. The data used is data on the amount of agricultural commodity production of food crops in Sekadau Regency and data on the total production of commodities of the two base subsectors in Sekadau Regency (tons) in the initial year (2016) and the final year (2020).

Table 4. Results of Shift-Share Analysis (SSA) of Food Crop Commodities and Plantations of Sekadau Regency, 2016 - 2020

Agricultural Commodities	Proportional Growth (PP)	Region Share Growth (PPW)	Net Growth (PB)	Shift-Share Analysis
Food Crops				
Rice	-0,05	0,67	0,62	Progressive
Corn	0,23	23,71	23,94	Progressive
Yam	0,23	-0,62	-0,39	Sluggish
Plantation				
Deep Coconut	-0,87	-0,08	-0,95	Sluggish
Cacao	-1,4	1,1	-0,31	Sluggish
Pepper	-0,38	8,28	7,91	Progressive
Coffee	-0,95	0	-0,95	Sluggish
Rubber	-0,93	-0,01	-0,94	Sluggish
Oil palm	0,08	-0,68	-0,59	Sluggish

Based on shift-share analysis, the progressive commodities of the food crop subsector are Rice and Corn with a Net Growth Value (PB) of ≥ 0. Rice has a PB value of 0.62 and corn has a PB value of 23.64. This shows that corn and rice in Sekadau Regency are classified as progressive commodities. In addition, this analysis also shows Proportional Growth (PP) which represents the sooner or slow growth in each subsector. As a result, two food crop commodities grow quickly, where pp results are positive, namely corn and sweet potatoes. Conversely, rice has a negative PP value which means that growth in these commodities is relatively slow. The Regional Share Growth Value (PPW) shows that rice and corn commodities equally have positive values in Sekadau Regency. That is, corn and rice have good competitiveness in Sekadau Regency. It can be seen that corn commodities have positive PP, PPW, and PB values in Sekadau Regency. While the yam commodity has a positive PP value and a negative PP value and PB value which indicates that growth is quite fast, but has poor competitiveness and is classified as a sluggish commodity.

Plantation subsector commodities that are classified as progressive with a PB value of ≥ 0 are only owned by pepper commodities, for other plantation commodities have a PB value of < 0 classified as sluggish commodities. Lada has a positive Regional Share Growth (PPW) value which indicates that the competitiveness of pepper is quite good in Sekadau Regency, but the proportional growth value (PP) is negative with slow growth. Cocoa and rubber have a negative PP and PB value, meaning that these two commodities show growth and belong to the slow group, but have a positive PPW value with fairly good competitiveness. Oil palm has a positive PP value with rapid growth, but the value of PPW and PB is negative which shows that oil palm in Sekadau belongs to the sluggish group and is less competitive. Deep coconut and rubber have all the values of PP,

PPW, and PB < 0, meaning slow growth, poor competitiveness, and classified as a sluggish group.

Third, Klassen Typology will show the position of sekadau regency's superior commodities by paying attention to West Kalimantan Province as its reference area. This analysis technique combines the results of LQ and Shift-Share analyses that have been done before to determine the region's superior commodities. The LQ value and Net Growth (PB) value in the SSA in each commodity subsector of food crops and plantations studied will be the quadrant determinants for these commodities.

Table 5. Results of Analysis of Superior Commodities of Food Crops and Plantations of Sekadau Regency

Agricultural Commodities	Value LQ	Value SSA	Klassen Typology
Food Crops			
Rice	Non-Base (LQ < 1)	Progressive (PB ≥ 0)	II
Corn	Base (LQ > 1)	Progressive (PB ≥ 0)	I
Yam	Base (LQ > 1)	Sluggish (PB < 0)	III
Plantation			
Deep Coconut	Non-Base (LQ < 1)	Sluggish (PB < 0)	IV
Cacao	Non-Base (LQ < 1)	Sluggish (PB < 0)	IV
Pepper	Non-Base (LQ < 1)	Progressive (PB ≥ 0)	II
Coffee	Non-Base (LQ < 1)	Sluggish (PB < 0)	IV
Rubber	Base (LQ > 1)	Sluggish (PB < 0)	III
Oil palm	Base (LQ > 1)	Sluggish (PB < 0)	III

According to the table above, it can be seen that the commodities subsector of food crops of Sekadau Regency consists of three quadrants. Corn occupies quadrant I which means a commodity that is developed and growing rapidly (developed commodity) with an LQ value of > 1 and a Net Growth value (PB) of ≥ 0. Rice occupies quadrant II which means a developed but depressed commodity (stagnant commodity) with an LQ value of < 1 and a Net Growth value (PB) of ≥ 0. Ubi occupies quadrant III which means a potential commodity (developing commodity) with an LQ value of ≥ 1 and a PB value of < 0.

Quadrant I Developed Commodity **Corn**	**Quadrant II** Stagnan Commodity **Rice**
Quadrant III Developing Commodity **Yam**	**Quadrant IV** Underdeveloped Commodity **-**

Fig.3 Matrix of Klassen Typology For Food Crop Commodities

The plantation subsector in Sekadau Regency also has three quadrants. Lada belongs to quadrant II as an advanced but depressed commodity (stagnant commodity) with a non-base LQ value and a progressive PB value. Rubber and palm oil including quadrant III become potential commodities (developing commodities) with base LQ value and sluggish PB value. Deep coconut, cocoa, and coffee are included in quadrant IV as relatively undeveloped commodities in Sekadau Regency with non-base LQ values and sluggish PB values.

Quadrant I Developed Commodity **-**	**Quadrant II** Stagnan Commodity **Pepper**
Quadrant III Developing Commodity **Rubber and Oil Palm**	**Quadrant IV** Underdeveloped Commodity **Deep Coconut, Cacao and Coffee**

Fig.4 Matrix of Klassen Typology For Plantation Commodities

4. Conclusion

Agricultural productivity in Sekadau Regency throughout 2016 - 2020 experienced mixed growth. Based on the results of the analysis, the basic and progressive agricultural subsectors in Sekadau Regency are owned by food crops and plantations. Furthermore, the superior commodities of the food crop subsector of Sekadau Regency consist of corn, rice, and sweet potatoes. Corn is an advanced and rapidly growing commodity (developed commodity). Rice is an advanced but depressed commodity (stagnant commodity). Sweet potatoes as a potential commodity (developing commodity). The superior commodities of plantation subsectors in Sekadau Regency consist of pepper, rubber, and oil palm. Pepper is an advanced commodity but depressed (stagnant commodity). Rubber and palm oil as potential commodities (developing commodities).

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6. Authors' Note

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7. References

Badan Pusat Statistik. (2021). **Produk Domestik Regional Bruto Kabupaten Sekadau Menurut Lapangan Usaha 2016-2020**. Badan Pusat Statistik Kabupaten Sekadau.

Direktorat Pengembangan Kawasan Khusus dan Tertinggal. (2003). **Pengembangan Ekonomi Daerah Berbasis Kawasan Andalan: Membangun Model Pengelolaan dan Pengembangan Keterkaitan Program**. Info Kajian Bappenas.

Harsono, Bayu D. (2012). **Analisis Sektor Basis Dan Pergeseran Struktur Perekonomian Kabupaten Sekadau**. Jurnal Ekonomi Daerah (JEDA) Vol 1, No 1 (2013). Diakses dalam https://jurnal.untan.ac.id/index.php/JEDA2/article/view/553

Jhingan M.L. (2012). **Ekonomi Pembangunan dan Perencanaan**. PT. Raja Grafindo Persada. Jakarta.

Ningsih, E. S. M. (2010). **Analisis Komoditi Unggulan Sektor Pertanian Kabupaten Sukoharjo Sebelum dan Selama Otonomi Daerah** [Tesis]. Fakultas Ekonomi dan Bisnis. Universitas Sebelas Maret. Surakarta. Diakses dalam https://digilib.uns.ac.id/dokumen/detail/12696/Analisis-komoditi-unggulan-sektor-pertanian-Kabupaten-Sukoharjo-sebelum-dan-selama-otonomi-daerah

Putri, Digna et al. (2020). **Analisis Komoditas Unggulan Berbasis Pertanian Di Kecamatan Sekadau Hilir, Kabupaten Sekadau**. Jurnal JeLast Vol 7, No. 2 (Juni, 2020) DOI: http://dx.doi.org/10.26418/jelast.v7i2.42148

Rudiantho, S. J. (2012). **Perencanaan Wilayah dan Pengembangan Ekonomi Lokal Berbasis Pertaian Teori dan Aplikasi**. Yogyakarta: Pustaka Pelajar.

Ryolla, Z. Q et al. (2018). **Strategi Pengembangan Komoditas Unggulan Subsektor Peternakan di Kota Singkawang**. Jurnal JeLast Vol 5, No. 2 (Juni, 2018) DOI: http://dx.doi.org/10.26418/jelast.v5i2.27722

Sjafrizal. (2008). **Ekonomi Regional, Teori dan Aplikasi.** Padang. Sumatera Barat: Boduose Media.

Sumodiningrat, G. (2000). **Membangun Ekonomi Melalui Pengembangan Pertanian**. Penerbit Bina Rena Pariwara. Jakarta.

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Effect Of Using Lead Rubber Bearing On A Steel Arch Bridge

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Abstract

A study was conducted to evaluate the application of Lead Rubber Bearing (LRB) on bridge structures. The length of steel arch bridge is 80 m, width of 10 m, and height of 19.6 m. The bridge is simply supported with two bearings on each support. Structural analysis reveals that the lateral force on the bearing is more than 400 tons (835 tons in longitudinal direction). The original designer's intention is to use pot bearings. However, the pot bearing was required to undergo some mechanical test to verify its properties prior to installation. Due to its size, this scheme is not applicable due to the limitations of the testing facility. Therefore, an alternative design was evaluated using LRB to reduce the reaction force, hence downsize the bearing size. The LRB used is of LRB 7500 characteristics, and the calculation refers to AASHTO Guide Specifications for Seismic Isolation Design (GSID), 4th edition 2014.

The analysis shows that applying LRB on the bridge lengthened the structural period from 0.76 seconds to 1.67 seconds. It also increased the damping ratio from 5% to 43 %. With these significant changes in structural parameters, lateral forces due to earthquake loads on the bearing and foundation can be greatly reduced. The study found that replacing pot bearings with LRBs can reduce the lateral force to 80 tons, approximately one fifth from the previous design. Correspondingly, the internal forces of some major structural components of the bridge can be reduced due to the application of LRB.

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1. Introduction

The construction of a bridge is important in the development of an area as indicated in a study by Nuh, S. M. (2021). The steel arch bridge being studied in this paper is assumed to be located at West Java. The length of the bridge is 80 m, with a height of 19.6 m and width of 10 m. The isometric view of the steel arch bridge is shown in Fig. 1.

The bridge is a simple span with two supports, i.e., abutment 1 and abutment 2, with two bearings at each abutment. The initial design of the bridge planned to use pot bearings as pinned (2 bearings) on one side and as rolls (2 bearings) on the other. After the design was completed and approved, it is found that the lateral force exerted on the bearing is 835 tons in longitudinal direction. The regulation requires that every bearing must be tested to verify its mechanical properties. With the large forces to be applied on the bearing and the limitation of the test facility, it is deemed not possible to use pot bearing as in the original design. Therefore, an alternative of design using Lead Rubber Bearing (LRB) is proposed. All structural components dimensions for model with LRB follow the original design using pot bearing model.

The LRB calculation refers to AASHTO Guide Specifications for Seismic Isolation Design (GSID) 2014. The specifications are intended for isolation systems that are essentially rigid in vertical direction and isolate in the horizontal plane only.

2. Material Properties

The materials used are steel for the bridge frame and concrete for the slab. The structural steel is JIS SM 490 YB and the standard steel/pipe is JIS SM 400 B / ASTM A53b, while the compressive strength of the concrete is f_c' 29 MPa.

In most applications, isolation systems must be rigid for non-seismic loads but flexible for earthquake loads (to enable required period shift). The LRB mechanical behavior is modeled using a bilinear model as shown in Fig. 2.

Table 1. Isolator properties by manufacturer

No	Description	Formula	Symbol	Unit	Value
1	Yielding displacement	$Q_d / (K_1-K_r)$	d_y	mm	9.00
2	Total yielding load	$Q_d + K_r*d_y$	F_y	kN	431.19
3	Horizontal load at maximum displacement	$Q_d + K_r*d_{max}$	F_{max}	kN	1183.08
4	Effective stiffness at maximum displacement	F_{max}/d_{max}	$K_{eff,max}$	kN/mm	3.79

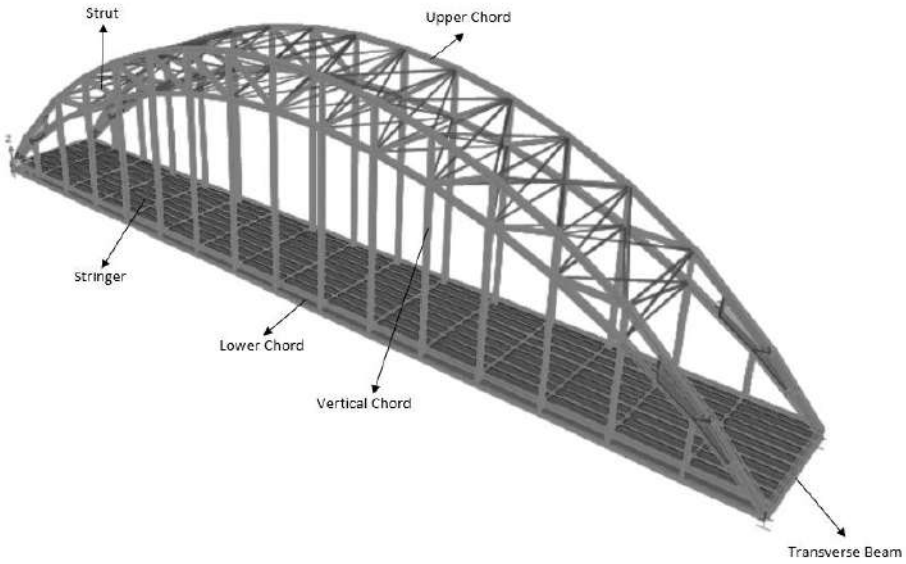

Fig.1 Isometric view of steel arch bridge

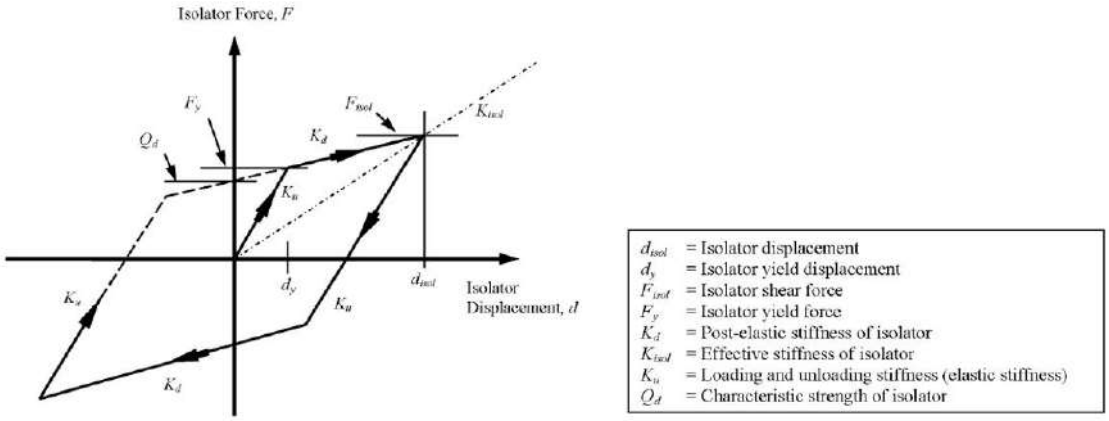

Fig.2 Properties of a bilinear isolator (AASHTO GSID, 2014)

3. Methodology

Although a nonlinear approach should be used to obtain better results, an approximated approach using linear analysis, of which equivalent linear springs and viscous damping are used to represent the isolators, are used in this study to determine the structural responses. The methodology adopts the simplified method to obtain initial estimates of the displacement to be used in an iterative solution involving the multimode spectral analysis method. The earthquake load is based on SNI 2833:2016, while other loads are taken from SNI 1725: 2016. In addition, for steel design, SNI 1729:2020 is used as main reference. Commercial software SAP 2000 which is widely used, such as in Murwanto and Priadi (2015), is used as the analysis tool.

3.1 Simplified Method

A single degree of freedom model of bridge, with equivalent linear properties and viscous dampers to represent the isolators, is analyzed iteratively to obtain estimated superstructure displacement (d_{isol} in Fig. 2, replaced by d to include substructure displacement) and required properties of isolators necessary to give the specified performance.

The simplified method steps as stipulated by AASHTO GSID (2014) are rewritten as follows for completeness and ease of reference:

Step 1: Initial system displacement and properties. To begin the iterative process, an estimate is required of: structure displacement, characteristic strength (Q_d) and post-yield stiffness (K_d).

Step 2: Initial isolator properties at supports. Calculate the characteristic strength (Q_{dj}) and post-elastic stiffness (K_{dj}) of the isolation system at each support "j" by distributing the total calculated strength (Q_d) and stiffness (K_d) values in proportion to the dead load applied at that support:

$$Q_{d,j} = Q_d \left(\frac{W_j}{w}\right)$$

and

$$K_{d,j} = K_d \left(\frac{W_j}{w}\right)$$

Step 3: Effective stiffness of isolator system. Calculate the effective stiffness (K_{eff}) of each support "j" for all supports, taking into account the stiffness of isolators at support "j" ($K_{isol,j}$) and the stiffness of the substructure ($K_{sub,j}$). For the abutments, take $K_{sub,j}$ to be a large number, unless actual stiffness values are available.

$$K_{eff,j} = \frac{\alpha_j K_{sub,j}}{1+\alpha_j}$$

where

$$\alpha_j = \frac{K_{d,j}d + Q_{d,j}}{K_{sub,j}d - Q_{d,j}}$$

Step 4: Total effective stiffness. Calculate the total effective stiffness (K_{eff}) of the bridge.

$$K_{eff} = \sum_{j=1}^{m} K_{eff,j}$$

Step 5: Isolation system displacement at each support. Calculate the displacement of the isolation system:

$$d_{isol,j} = \frac{d}{1+\alpha_j}$$

Step 6: Isolation system stiffness of the isolation system at support "j", ($K_{isol,j}$) for all supports:

$$K_{isol,j} = \frac{Q_{d,j}}{d_{isol,j}} + K_{d,j}$$

Step 7: Substructure displacement at each support. Calculate the displacement of substructure "j", ($d_{sub,j}$) for all support:

$$d_{sub,j} = d - d_{isol,j}$$

Step 8: Lateral load in each substructure support. Calculate the shear at support "j", ($F_{sub,j}$) for all supports:

$$F_{sub,j} = K_{sub,j} d_{sub,j}$$

Step 10: Effective period and damping ratio. Calculate the effective period, (T_{eff}) and viscous damping ratio (ξ) of the bridge:

$$T_{eff} = 2\pi\sqrt{\frac{W_{eff}}{gK_{eff}}}$$

and

$$\xi = \frac{2\sum_j\left[Q_d\left(d_i - d_y\right)\right]}{\pi\sum_j\left[K_{eff,j}(d_i + d_{sub})^2\right]}$$

Step 11: Damping factor. Calculate damping factor (B_L) and the displacement (d) of the bridge:

$$B_L = \begin{cases} \left(\frac{\xi}{0.05}\right)^{0.3} & \xi < 0.3 \\ 1.7 & \xi \geq 0.3 \end{cases}$$

and

$$d = \frac{9.79 S_{D1} T_{eff}}{B_L}$$

Step 12: Convergence check. Compare the new displacement with the initial value assumed in step 1. If there is close agreement, go to next step; otherwise repeat the process from Step 3 with the new value for displacement as the assumed displacement.

3.2. Multimode Spectral Analysis Method

For the completeness of discussion and ease for reference, the following section is quoted from AASHTO GSID (2014). For the multimode spectral analysis method, the five percent damped ground-motion spectrum shall be used. The scaled spectrum may be obtained using the damping coefficient (B_L) to include the effective damping of the isolation system for the isolated modes. Scaling by the damping coefficient B_L shall apply only for periods greater than 0.8 T_{eff}. The five percent damped response spectrum shall be used for all other modes. The effective linear stiffness of the isolators shall correspond to the design displacement. Structure system damping shall include all structural elements and obtained by a rational method. The combination of orthogonal seismic forces shall be as specified in Design Specification.

In the multimode spectral analysis method, a three-dimensional multi-degree-of-freedom model of the bridge, with equivalent linear springs and viscous dampers to represent the isolators, is analyzed iteratively to obtain final estimates of superstructure displacement and required properties of each isolator to satisfy performance requirements. The results from the simplified method are used to determine initial values for the equivalent spring elements for the isolators as starting point in the iterative process. The design response spectrum is modified for the additional damping provided by the isolators and applied in longitudinal direction of bridge.

Step 1: Characteristic strength. Calculate the characteristic strength ($Q_{d,j}$) and post-elastic stiffness ($K_{d,j}$) of each isolator "i" as follows:

$$Q_{d,j} = \left(\frac{Q_{d,j}}{n}\right)$$

and

$$K_{d,j} = \left(\frac{K_{d,j}}{n}\right)$$

Where values for $Q_{d,j}$ and $K_{d,j}$ are obtained from final cycle of iteration in the simplified method.

Step 2: Initial stiffness and yield displacement. Calculate the initial stiffness ($K_{u,i}$) and the yield displacement ($d_{y,i}$) for each isolators "i" as follows:

(1) For friction-based isolators: $K_{u,i} = \infty$ and $d_{y,i} = 0$
(2) For other types of isolators, and in absence of isolator-specific information, take

$$K_{u,i} = 10K_{d,i}$$

and

$$d_{y,i} = \frac{Q_{d,i}}{K_{u,i} - K_{d,i}}$$

Step 3: Isolator effective stiffness. Calculate the isolator stiffness, ($K_{isol,i}$) of each isolator "i":

$$K_{isol,i} = \frac{K_{isol,j}}{n}$$

Step 4: Three-dimensional bridge model. Using computer-based structural analysis software, create a three-dimensional model of the bridge with the isolators represented by spring elements.

Step 5: Composite design response spectrum. Modify the response spectrum to obtain a "composite" response spectrum. This is done by dividing all spectral acceleration values at period above 0.8 x the effective period of the bridge (T_{eff}) by the damping factor (B_L).

Step 6: Multimode analysis of finite element model. Input composite response spectrum as a user-specified spectrum in software and define a load case in which spectrum is applied in the longitudinal direction. Analyze the bridge for this load case.

Step 7: Convergence check. Compare the resulting displacements at the superstructure level (d) to the assumed displacements. If in close agreement, go to step 9. Otherwise, go to step 8.

Step 8: Update $K_{isol,i}$, $K_{eff,j}$, ξ, and B_L. Use the calculated displacements in each isolator element to obtain new values of $K_{isol,i}$ for each isolator as follows:

$$K_{isol,i} = \frac{Q_{d,i}}{d_{isol,i}} + K_{d,i}$$

Recalculate $K_{eff,j}$:

$$K_{eff,j} = \frac{K_{sub,j} \sum K_{isol,i}}{\left(K_{sub,j} + \sum K_{isol,i}\right)}$$

Recalculate system damping ratio, ξ:

$$\xi = \frac{2 \sum_j \sum i \left[Q_{d,i}\left(d_{isol,i} - d_{y,i}\right)\right]}{\pi \sum_j \sum i \left[K_{eff,j}\left(d_{isol,i} + d_{sub,j}\right)^2\right]}$$

Recalculate system damping factor, B_L:

$$B_L = \begin{cases} \left(\frac{\xi}{0.05}\right)^{0.3} & \xi < 0.3 \\ 1.7 & \xi \geq 0.3 \end{cases}$$

Obtain the effective period of the bridge from the multimode analysis and with revised damping factor, construct a new composite response spectrum.

Step 7: Convergence check. Compare the resulting displacements at the superstructure level (d) to the assumed displacements. If in close agreement, go to step 9. Otherwise, go to step 8.

Step 9: Once convergence has been reached, obtain superstructure and isolators displacements in the longitudinal and transverse directions of the bridge.

3.3. Isolator Parameter

Based on multimode analysis last iteration, updated values for $K_{isol,i}$ are given below (previous values are in parentheses):

$K_{isol,1}$ = 5216.9 (5148.7) kN/m

$K_{isol,2}$ =5216.9 (5148.7) kN/m

$K_{isol,3}$ = 5216.9 (5148.7) kN/m

$K_{isol,4}$ = 5216.9 (5148.7) kN/m

Update values for K_{eff}, ξ, B_L, and T_{eff} are given below (previous cycle calculated values are shown in parentheses):

$K_{eff,1}$ = 10372 (10237) kN/m

$K_{eff,2}$ = 10372 (10237) kN/m

$K_{eff,3}$ = 10372 (10237) kN/m

$K_{eff,4}$ = 10372 (10237) kN/m

ξ = 43 percent (43 percent)

B_L = 1.70 (1.70)

T_{eff} = 1.67 (1.68) s

Reanalysis gives the following values for the isolator displacement (numbers in parentheses are from previous cycle):

$d_{isol,1}$ = 0.149 (0.151) m

$d_{isol,2}$ = 0.149 (0.151) m

$d_{isol,3}$ = 0.149 (0.151) m

$d_{isol,4}$ = 0.148 (0.151) m

Based on calculations using the simplified method and multimode spectral analysis method, the final value of the isolator effective stiffness ($K_{isol,i}$) is 5216.90 kN/m. This value is utilized as the equivalent linear springs in each direction under consideration. Then, the response spectrum is modified by dividing all spectral acceleration values at period above 0.8 T_{eff} by the damping factor (B_L) of 1.70 to obtain composite response spectrum in the last iteration.

Next, combined results from longitudinal and transverse analysis using the (1.0L + 0.3T) and (0.3L + 1.0T) are used to obtain design values for isolator and superstructure displacements. The total design displacement is the governing resultant displacement at an isolator unit obtained from the results of two load cases, i.e. (1.0L + 0.3T) and (0.3L + 1.0T).

The resultant isolator displacements for each load case are calculated from the specified combinations of the maximum longitudinal and transverse displacements from two analyses, one in the longitudinal direction and the other in the transverse. The total design displacement is the largest of the resultant displacements from the two load cases (Fig. 3.). The displacement of the final iteration ($d_{isol,i}$) is close to the previous iteration as shown in Table 2.

The three-dimensional steel arch bridge modeled with the isolators represented by spring elements using the multimode spectral analysis method is shown in Fig. 4.

Table 2. Convergence check in the final iteration cycle

Step	**B2.1**	**B2.1**	**B2.3**	**B2.8**	**B2.8**		**B2.6**
	First iteration				**Final Iteration**		
	$Q_{d,i}$	$K_{d,i}$	$K_{isol,i}$	$K_{isol,i}$	$K_{eff,j}$	*Prev*	$d_{isol,i}$
	kN	kN/m	kN/m	kN/m	kN/m	m	m
Abutment 1	409	2500	7729.64	5216.90	10372.01	0.151	0.149
Abutment 2	409	2500	7729.64	5216.90	10372.01	0.151	0.149

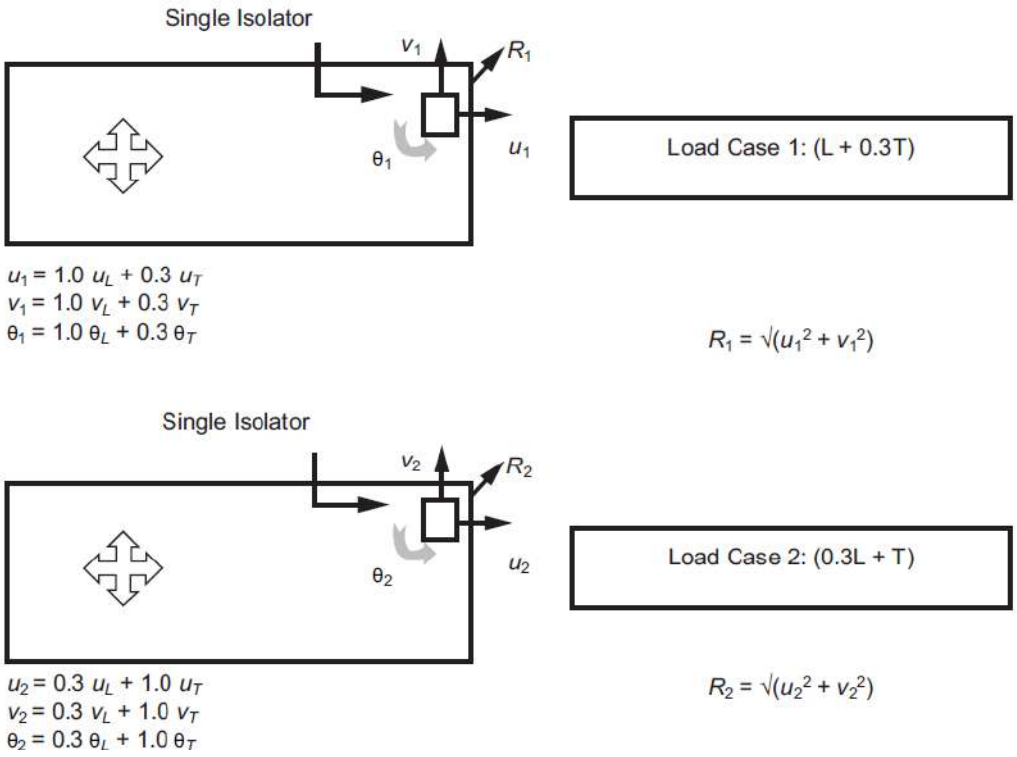

Fig.3 Total design displacement = max [R_1, R_2] (AASTHO GSID, 2014)

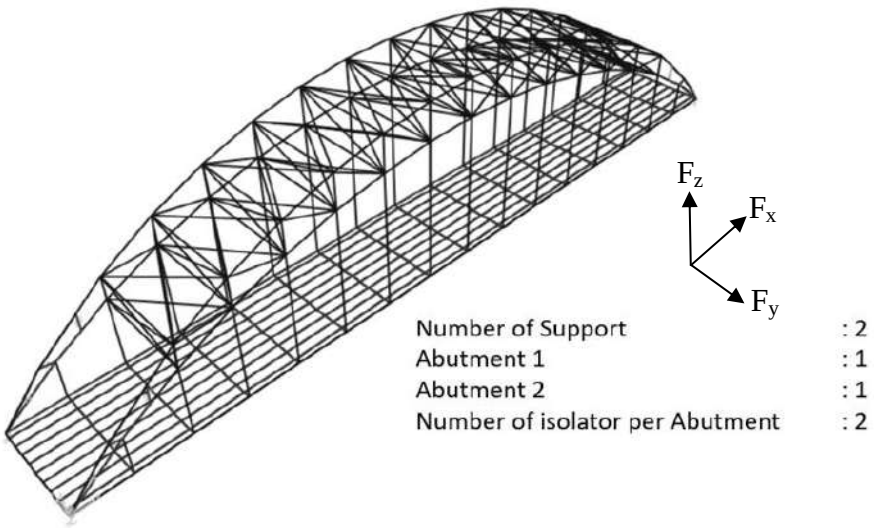

Fig.4 Three-dimensional steel arch bridge model

4. Results and Discussion

Based on the results of the final iteration (after convergence), the period of the bridge structure shifted from 0.76 seconds (pot bearing model) to 1.67 seconds (LRB model). The composite design response spectrum used in the final iteration is illustrated in Fig. 5. The isolator stiffness in the final iteration meets the isolator bilinear curve of LRB 7500 (Fig. 6). In addition, the lateral force and lateral displacement of the isolator does not exceed the maximum force capacity and the maximum displacement capacity of the LRB 7500 isolator. The forces obtained from the analysis of the superstructure that will be resisted by the bridge bearing can be summarized as follows:

Abutment 1:

F_z = 5148 kN (gravity),

F_x = 790 kN (longitudinal), and

F_y = 687 kN (transverse)

Abutment 2:

F_z = 5148 kN (gravity),

F_x = 790 (longitudinal), and

F_y = 687 kN (transverse)

It is worth noticing that replacing the pot bearing with LRB can reduce the lateral force on bearings from more than 400 tons (835 tons in longitudinal direction) for non-isolated bridge to less than 80 tons for isolated bridge (LRB). This is due to the longer structural period and the use of the composite design response spectrum.

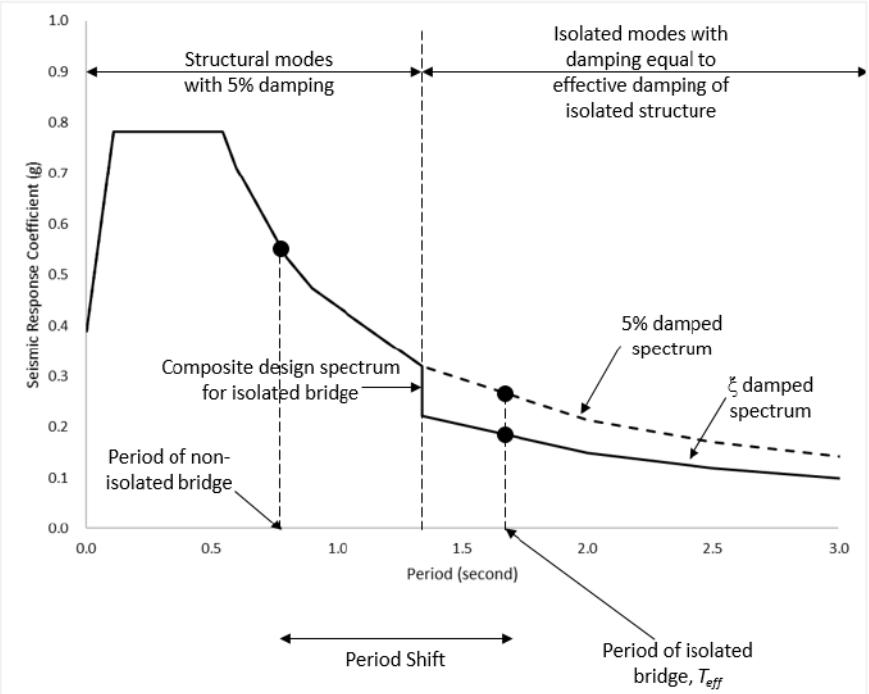

Fig.5 Composite design response spectrum

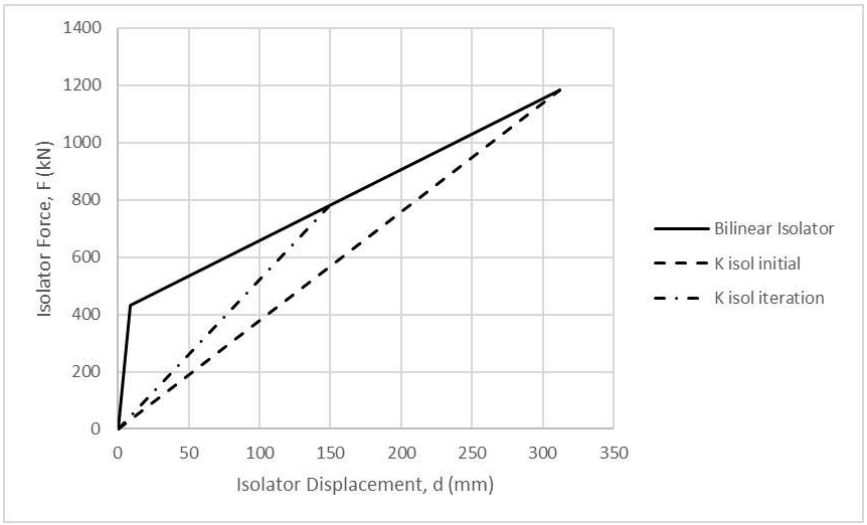

Fig.6 Bilinear isolator of LRB 7500

The combined results from longitudinal and transverse analyses of the bridge using the LRB 7500 shows that the displacement of the LRB due to extreme load combinations does not exceed the amplified displacement (1.25 x design displacement) of LRB 7500 specification. The displacements are presented in Table 3.

As can be seen in Table 3, the maximum displacement in both longitudinal and transverse direction are 153 mm and 132 mm, respectively. Hence, the analysis show that the displacement demand obtained from the analysis is still smaller than the amplified displacement capacity of the isolator, i.e., 312.5 mm.

Utilizing similar components as in the original design, the elements of superstructure are then evaluated. The loading combination used for design refer to SNI 1725:2016 and SNI 2833:2016. After reanalysis of the LRB model, results reveal that the internal forces can be reduced for the steel components, indicated by the demand-to-capacity (DCR) values, given in Table 4. From the obtained DCR values, a significant reduction is achieved for lower chords, struts, and vertical chords. The DCR value of the lower chord reduces from 0.98 (pot bearing model) to 0.62 (LRB model), and the DCR value for strut shows a reduction from 0.75 to 0.40 for pot and LRB model, respectively.

Table 3. Displacement of an isolator

Joint	Max. Displacement		Amplified Displacement	Result
	Longitudinal	Transverse		
	mm	mm	mm	
1	153.16	131.81	312.50	OK
2	152.96	130.90	312.50	OK
3	152.96	130.90	312.50	OK
4	153.16	131.81	312.50	OK

Table 4. Maximum demand-to-capacity ratio (DCR) of major steel bridge components

No.	Component	DCR (Lead Rubber Bearing)	DCR (Pot Bearing)	DCR ≤ 1.0
1	Lower Chord	0.62	0.98	OK
2	Transverse Beam	0.85	0.82	OK
3	Stringer	0.73	0.73	OK
5	Upper Chord	0.81	0.87	OK
6	Strut	0.40	0.75	OK
7	Vertical Chord	0.68	0.87	OK

5. Conclusion

The use of LRB on the steel arch bridge evaluated in this study reveals that a significant change in lateral forces of bearing can be obtained. A reduction of the lateral force on bearing that was previously more than 400 tons (835 tons in longitudinal direction) for non-isolated bridge, to less than 80 tons for isolated bridge (LRB). This reduction could also lead to a more economical design of the foundation system. In addition, the evaluation of both lateral force and displacement of the isolator shows that it conforms to the maximum force and displacement capacity of the isolator LRB 7500. Using the composite response spectrum, the application of LRB lengthens the structural period and increases the damping ratio which eventually results in reduction of internal forces of the major structural components reflected in the reduction of their DCR ratios.

6. Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. References

American Association of State Highway and Transportation Officials. (2014). **Guide Specifications for Seismic Isolation Design, 4th edition.** Washington DC.

American Association of State Highway and Transportation Officials. (2017). **LRFD Bridge Design Specifications.** Washington DC.

Badan Standarisasi Nasional. (2016). **SNI 1725:2016 Pembebanan Untuk Jembatan**. Jakarta.

Badan Standarisasi Nasional. (2016). **SNI 2833:2016 Perencanaan Jembatan Terhadap Beban Gempa.** Jakarta

Badan Standarisasi Nasional. (2020). **SNI 1729:2020 Spesifikasi Untuk Bangunan Gedung Baja Struktural.** Jakarta.

Murwanto, Y. and Priadi, E. (2015). **Kajian Lendutan pada Jembatan Rangka Baja (Studi Kasus Jembatan Rangka Baja Bika Kabupaten Kapuas Hulu)**. Journal of Civil Engineering, University of Tanjungpura, Vol 15, No. 2.

Nuh, S. M. (2021). **Analisis Kelayakan Ekonomi Pembangunan Jembatan Melawi di Kabupaten Melawi**. Journal of Civil Engineering, University of Tanjungpura, Vol. 21, No. 1.

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The Effect of Coarse Aggregate Size On Pervious Concrete Mixture

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Abstract

Along with the development progress in Indonesia, it causes the reduction of green areas. Coupled with the lack of public awareness of the environment is a problem that must be considered. Pervious concrete that be as one of the solutions in pavement construction, concrete sheet piles, retaining walls is a product that can be considered successfully in meeting expectations as an environmentally friendly construction. For road pavement, pervious concrete must have a strength of 30 MPa. Therefore, there is a need for research for the mix design of pervious concrete using the ACI 522R-10 Report on Pervious Concrete method with an initial design compressive strength of 25 MPa. The method is to vary the coarse aggregate used in the pervious concrete mixture. In this research, it is divided into 5 variations to find a mixture that is in accordance with the plan or which exceeds the initial plan, and its permeability still meets the requirements for pervious concrete. Testing of the specimens includes the volume weight test, compressive strength, split tensile strength, modulus of elasticity of concrete, porosity, absorption, and permeability. From the research, the results of the volume weight of pervious concrete are 1,974.14 - 2,187.83 kg/m^3 that pervious concrete is included in the lightweight concrete group due to it has a weight below 2,200 kg/m^3. The average compressive strength of pervious concrete is 20.089 – 46.978 MPa. The value of the split tensile strength of pervious concrete is 8,968-19,127 MPa. The average value of porosity is between 8,307 – 13,097%. The average value of absorption is between 3.452 – 5.444%. The average value of the permeability is between 0.0025-0.487 cm3/sec. From this research, it can be concluded that the use of different coarse aggregates size will produce pervious concrete with different compressive strengths. The compressive strength with aggregate size 0.5x0.5 without sieving, it closed to the initial plan of 27.72 MPa, whereas the highest compressive strength is for a mixed aggregate size of 1/1 and 0.5/0.5 cm with sieving that the compressive strength achieved 46.978 MPa.

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pervious concrete, physical and mechanical properties, variation of aggregate, with sieving, without sieving

1. Introduction

Pervious concrete consists of agglomeration of single-sized coarse aggregate covered with a thin cement paste layer of about 1.3 mm (Neville and Brooks, 2010).

Based on ACI 522R-10 mix design for pervious concrete consists of: cement (270 - 415 kg), aggregate (1190 - 1480 kg), cement water factor (0.27 - 0.34), ratio of sand and gravel weight (0 to 1:1) by using chemical admixtures.

The addition of sand will reduce the pore content and increase the compressive strength. The use of non-sand concrete as a pavement material is very limited and has not been developed for certain applications. However, non-sand concrete has been widely used as a structural building material in Europe, Australia and the Middle East for more than 70 years (Harber, 2005). The earliest use of pervious concrete occurred in England in 1852 with the construction of two dwelling houses and a sea grove 61 m long and 2.15 m wide (Harber, 2005). The use of non-sanded concrete became much more widespread during the material shortage after World War II, for cast-in-place load-bearing walls for non-rise and multi-storey buildings.

The initial use of non-sand concrete was mainly for two-story structures, then it was developed for five-story buildings in the 1950s and continues to grow. In recent years, pervious concrete has been used as a load-bearing material in high-rise buildings of up to ten stories. The most remarkable use of pervious concrete was in Stuttgart, Germany where high-rise buildings were constructed using conventional

concrete for the lower six floors and non-sand concrete for the remaining thirteen upper floors (Harber, 2005).

The specific gravity of pervious concrete is generally about 70% of conventional concrete if made with the same material. The specific gravity of pervious concrete using conventional aggregates varies from 1602 to 1922 kg/m^3. Clinker aggregate has been tested and the pervious concrete produces a specific gravity of 961 kg/m3 (Harber, 2005).

(Abadjieva and Sephiri, 2000) conducted a study of pervious concrete with a ratio of weight of aggregate to cement from 6 : 1 to 10 : 1. The compressive strength of pervious concrete at the age of 28 days varied from 1.1 to 8.3 MPa, depending on the ratio of aggregate to cement. , and the decrease occurred with increasing the ratio of aggregate to cement. The mixture with the ratio of aggregate to cement 6:1 is the strongest. The compressive strength of pervious concrete is lower than the compressive strength of conventional normal concrete due to an increase in porosity. The highest tensile strength and flexural strength occurred at the ratio of aggregate to cement 7:1 and the decrease occurred with increasing ratio of cement to aggregate. The tensile strength and flexural strength of pervious concrete are lower than conventional normal concrete (Ginting, 2015).

Non-sand concrete has several advantages, including (Kusuma, 2013):

- *Low Shrinkage*, the total shrinkage of non-sanded concrete when hardened/dry is about half that of solid concrete made with the same aggregate. The shrinkage rate is also much faster. The total shrinkage movement, it has been found that 50% to 80% occurs in the first 10 days, whereas for solid concrete only 20 to 30 percent will occur in the same period. This means that the danger of cracking is much less when compared to normal concrete.
- *Light Weight*, due to the use of lightweight aggregate, lightweight concrete is produced.
- *Thermal insulation*.
- *Eliminated segregation*.
- *Reduce cement demand*, the need for cement is small because it does not use sand, so the aggregate surface area is reduced.
- *Simple*, which means how to make it simple and faster.
- *Sound insulation*.
- *Environment Friendly*, easy to pass water, can be used as a material for making infiltration wells, thereby increasing infiltration into the soil.

Non-sand concrete has several disadvantages, some of which are (Kusuma, 2013):

- *Porous*, non-sand concrete is not recommended with reinforcing steel especially if it is in an aggressive environment, its pervious nature can accelerate the corrosion rate of the structure.
- *Low compressive strength*, due to its light weight, the compressive strength of non-sand concrete is very low so that the application is very limited.

Figure 1. a pervious concrete

This research aims to determine the effect of coarse aggregate size in the pervious concrete mixture that is designed.

2. Methodology and Literature Review

The research study is a literature study and an experimental study on pervious concrete. The research location is at the Materials and Construction Laboratory, Faculty of Engineering, Universitas Tanjungpura, Pontianak and a concrete workshop on Jalan Reformasi Untan.

2.1. Material

The materials used in the manufacture of pervious concrete are as follows:

1. The cement used is type PCC.
2. The stones used are 1/1 cm and 0.5/0.5 cm. Where is this stone, some are sieved and some are not sieved.
3. The water used is PDAM water with a PH of 6-7.
4. Superplasticizer with the trademark Sikamen LN issued by PT Sika.
5. The planned compressive strength is 25 MPa.
6. W/C used 0.26
7. Mixing standard based on ACI 522R-10
8. Mineral admixture that used is Sikafume.

2.2. Equipment

The equipment used in this test are a compressive testing machine, bearing block, compressometer, concrete cube, concrete cylinder, vibrating sieve machine (shieve sekker machine), material oven, weighing machine mixer, Los Angeles machine, slump tools, organic plates and other support tools.

2.3. Research Method

The research method is as follows:

1. *Material preparation and test*
   a. Collection of theoretical basis, previous research journals that support this research
   b. Preparation of materials and testing of materials
2. *Concrete mix design*. Calculation of the concrete mix design using ACI 522R-10 with a design compressive strength of 25 MPa. Calculation of the need for the manufacture of test specimens as many as 5 variations of specimens, five variations of specimens with gradation of coarse aggregate.

3. *Casting the test specimens*, is made in the form of a cube with a size of 15 x 15 cm and a cylinder with a diameter of 15 cm and a height of 30. The casting of the test object is assisted with a concrete mixer machine.
4. *Test object treatment*. Treatment of the test specimens is carried out by immersing it in a tub filled with water at room temperature. Treatment is carried out one day after casting to one day before testing.
5. *Volume weight test.* Testing the weight volume of the concrete cylinder using an electric scale with an accuracy of 0.05 kg at the age of 3, 7, 14, 21, 28 days of concrete.
6. *Compressive strength test*. Testing the compressive strength of concrete based on SNI 03-1974-2011, this research uses a compressive testing machine brand MTB with a capacity of 2,000 kN and an accuracy of 5 kN at the age of 3, 7, 14, 21, 28 days.
7. *Permeability Test*. Permeability testing is carried out to determine and measure the ease with which water can pass through the concrete. The test is carried out using a permeability tool
8. *Split tensile strength test*. Split tensile strength testing is based on SNI 03-2491-2002, this research uses a bearing block and a MTB brand compressive testing machine with a capacity of 2000 kN and an accuracy of 5 kN at the age of 28 days.

2.4. Analysis Method

1. Volume weight can be calculated by the formula :

$$W_c = \frac{m}{V} \quad \text{.....(1)}$$

Where:

Wc = Volume weight (kg/m^3)
m = Concrete weight (kg)
V = Concrete volume (m^3)

Compressive strength can be calculated by the formula :

$$f_c = \frac{P}{A} \quad \text{..... (2)}$$

Where;

f_c = compressive strenght (MPa)
P = maximum load test (N)
A = contact area (mm^2)

2. Permeability coefficient can be calculated by the formula :

$$K = \frac{\rho g L Q}{P A} \quad \text{.....(3)}$$

Where:

K = permeability coefficient (cm^3/det)
ρ = density of water (kg/cm^3)
g = acceleration of gravity (cm/det^2)
L = length or height of sample (cm)
Q = flow rate of water (cm^3/det)
P = Water pressure (kg cm/det^2/cm^2)
A = contact area of sample (cm^2)

3. Split tensile strength can be calculated by the formula:

$$f'_{ct} = \frac{2P}{\pi t D} \quad \text{.....(4)}$$

where :

f'_{ct} = split tensile strength of concrete (N/mm^2)
P = maximum compressive load when concrete cylinder split/collapsed (N)
π = phi (3,14)
t = height/length of concrete cylinder (mm)
d = diameter of concrete cylinder (mm)

2.5. Population and Sample

The population is all objects to be studied in this study, namely cylinders with a cylinder size with a diameter of 150 mm, and a height of 300 mm.

Table 1. List of Laboratory Specimens for Test Sample

No	Test Specimen	Compressive Test					Split Tensile Test	Porosity, permeability
		Day to					Day to -	Day to -
		3	7	14	21	28	28	28
Var 1	Cylinder	5	5	5	5	5	5	5
Var 2	Cylinder	5	5	5	5	5	5	5
Var 3	Cylinder	5	5	5	5	5	5	5
Var 4	Cylinder	5	5	5	5	5	5	5
Var 5	Cylinder	5	5	5	5	5	5	5
Total		**125**					**25**	**25**

Where:

Var 1 = A mixture of cement, sieved stone 1/1 cm, water, SF and SP.
Var 2 = A mixture of cement, 50% of 1/1 cm stone + 50% of sieved 0,5/0,5 cm stone, water , SF and SP.
Var 3 = A mixture of cement, unsieved 1/1 cm stone, water, SF and SP.
Var 4 A mixture of cement, sieved 0,5/0,5 cm stone, water, SF and SP.
Var 5 A mixture of cement, unsieved 0,5/0,5 cm stone, water, SF and SP.

3. Results and Discussion

3.1. Material Testing

3.1.1. Cement

The elements contained in the PCC Conch cement used are as follows:

Table 2. Composition of PCC Conch cement

Element	(%)
Silicon Dioxide (SiO_2)	23,64
Alumunium Oxide (Al_2O_3)	8,4
Ferric Oxide (Fe_2O_3)	4,36
Calcium Oxide (CaO)	58,38
Magnesium Oxide (MgO)	1,91
Sulfur Trioxide (SO_3)	2
Lost Incand (LOi)	3,28
Free Lime	0,56
Undissolved part	8,96

3.1.2. Water

The water used is PDAM water with a PH of 7 and clean conditions because the water can be used for drinking water. This water data was obtained from the results of previous research on pervious concrete.

3.1.3. Chemical Admixture

Chemical admixtures are usually used in small amounts in pervious concrete mixture. The purpose of its use is to improve certain properties of the mixture, especially to speed up the drying process in pervious concrete.

In this study, Sikamen LN and Silica Fume were used as chemical admixtures to reduce the water level of the concrete specially formulated for the precast concrete element industry, to increase the initial strength of the concrete so that the formwork can be quickly released and can be used as much as possible so that the time used can be accelerated. So from these data it can be concluded that Sikamen LN is a type F chemical admixture with high initial strength and water reduction.

Sikamen LN is a dark brown liquid from PT Sika Indonesia. Using Sikaman LN will be able to reduce air by 20%, will result in a 40% increase in 28 days of compressive strength and an increase in airtightness. Its density is 1.22 ± 0.01 kg/L at 2+20 °C

Meanwhile, the usage limit of Sikamen LN is at a dose level of 0.30% - 2.0% of the total weight of cement material depending on the requirements regarding workability and strength. It is recommended that a trial mixture be carried out to determine the appropriate level of need. Typical dosage rates for use with silica sand are 0.30% - 1.20% by weight of cementitious materials.

Silicafume is an excellent and high-performance additive for concrete mixture, in order to produce high-performance concrete. The use of silicafume as much as 25% of the weight of cement is the most optimum silicafume content for the manufacture of concrete (*Wille, et al., 2011*)

3.1.4. Coarse Aggregate (split stone)

Split stone is a coarse aggregate used in this study as an ingredient in the manufacture of pervious concrete. The split stone used is the stone originating from West Kalimantan. For this study used 2 types of split stone sizes, namely split stone measuring 1/1 cm and split stone measuring 0.5 / 0.5 cm which is sieved sieve and not sieved with a sand.

3.1.4.1. Physical and mechanical data 1 cm/1 cm stone

The type of aggregate is distinguished in two conditions, namely the saturated surface dry (SSD) state and the absolute dry state or oven dry state. In this examination, the absorption value will also be obtained, namely the ratio between the weight of water absorbed by the aggregate in a saturated surface condition and the weight of the aggregate in an oven dry state.

Inspection of specific gravity aims to determine the specific gravity and percentage of water weight that can be absorbed by coarse aggregate (stone), calculated against dry weight. The results can be seen in the table below:

Table 3. Results of Examination of Coarse Aggregate Size 1/1

No	Type of Examination	Examination Result	Unit
1	Absorption	0,103	%
2	Volume weight	1.571	kg/m^3
3	Water content	1,6	%
4	Fineness Modul	6,62	-
5	Aggreagate wea	9,1	%
6	Mud content	0,4	%
7	Specific gravity	1.780	kg/m^3

The value of fineness modulus for coarse aggregate (split) with a size of 1 cm / 1 cm is 2,919. This coarse aggregate is classified as good coarse aggregate because it has fineness modulus value between 2 - 8. So that it meets the requirements for use in concrete with a strength of 25 MPa.

3.1.4.2. Physical and mechanical data of stone size 0.5/0.5 cm

The type of aggregate is distinguished in two conditions, namely the saturated surface dry state (SSD) and the absolute dry state or oven dry state (oven dry). In this examination, the absorption value

will also be obtained, namely the ratio between the weight of water absorbed by the aggregate in a saturated surface condition and the weight of the aggregate in an oven dry state.

Inspection of specific gravity aims to determine the specific gravity and percentage of water weight that can be absorbed by coarse aggregate (stone), calculated against dry weight. The results can be seen in the table below.

Table 4 Results of Examination of Coarse Aggregate Size 0.5 cm / 0.5 cm:

No	Type of Examination	Examination Results	Unit
1	Absorption	0,188	%
2	Volume weight	1.668	kg/m^3
3	Water content	0,272	%
4	Fineness Modulus	2,75	-
5	Aggregate wear	12,21	%
6	Mud content	2,4	%
7	Specific gravity	2.455	kg/m^3

The value of fine grain modulus (MHB) for coarse aggregate (split) with a size of 0.5/0.5 cm is 2.750. This coarse aggregate is classified as good coarse aggregate because it has an fineness modulus value between 2 - 8. So that it meets the requirements for use in concrete with a strength of 25 MPa.

3.1.5. Fine Aggregat

The type of aggregate is distinguished in two conditions, namely the saturated surface dry state

(SSD) and the absolute dry state or oven dry state (oven dry). In this examination, the absorption value will also be obtained, namely the ratio between the weight of water absorbed by the aggregate in a saturated surface condition and the weight of the aggregate in an oven dry state.

Inspection of specific gravity aims to determine the specific gravity and percentage of water weight that can be absorbed by fine aggregate (sand), calculated against dry weight. The results can be seen in the table below:

Table 5. Fine Aggregate Inspection Results

No	Type of Examination	Hasil Pemeriksaan	Unit
1	Absorption	0,08	%
2	Volume weight	1.668	kg/m^3
3	Water content	0,421	%
4	Fineness	2,002	-
5	Aggregate	2	warna
6	Mud content	5	%
7	Specific gravity	2.518	kg/m^3

The volume weight of the fine aggregate was checked in the loose and solid state. Analysis of the average volume weight obtained by sand is 1,668 kg/m^3.

3.2. Composition of Pervious Concrete Mixture with ACI 552R

From the material data obtained, a mix design for pervious concrete is made referring to the ACI 522R-10 Report on Pervious Concrete regulations, because at this time Indonesia does not yet have SNI for pervious concrete. From the analysis carried out, the data obtained are as follows;

Tabel 6 Total material requirement for 1m^3

Material	Var1	Var2	Var3	Var4	Var5
	Kg				
Cement	382,61	382,61	382,61	382,61	382,61
Air	114,4	14,41	14,41	14,41	14,41
Coarse Aggregate 1/1 cm (sieved)	1480,73	740,365			
Coarse Aggregate 0,5/0,5 cm (sieved)		740,365		1480,73	
Coarse Agregat 1/1 cm (unsieved)			1480,73		
Coarse Aggregate 0,5/0,5 cm (unsieved)					1480,73
Selicafume	57,39	57,39	57,39	57,39	57,39
Superplasticizer	7,65	7,65	7,65	7,65	7,65

3.3. Pervious Concrete Analysis

Pervious concrete is the final subject of this study. The study of pervious concrete used a cylindrical specimen with a diameter of 15 cm and a height of 30 cm. Where for the material composition plan obtained from previous research, namely from journal materials using water cement ratio (w/c) 0.26.

3.3.1. Slump Test

Slump testing is very important to determine the level of workability and the resulting material. Where the slump test is carried out. The data from the research that has been done obtained the following data:

Tabel 7. Slump Test

No	Variasi	Slump Test (cm)
1	Var 1	19,5
2	Var 2	17
3	Var 3	17
4	Var 4	4,8
5	Var 5	4,5

From the table it can be seen that the slump test is obtained for an average of 45 – 195 mm. Based on the SNI regulations for concrete construction, it is required that the best concrete is with a slump of 25-100 mm. Thus, only Var4, and Var5 fulfill these conditions. For Var1, Var2 and Var3 too dilute. This is caused by using too much water or too much sikament. Thus it is necessary to reduce water by 10% with the addition of LN.

3.3.2. Volume Weight Test

The results of the average volume/content weight of the pervious concrete that have been tested for the sample size of the cylindrical sample with a diameter of 15 cm and a height of 30 cm from each variation of the mixture for each age obtained the following data:

Table 8. Volume Weight/content average age 3,7,14,21 and 28 days

Variation	Avarage Volume Weight (Kg/m^3)				
	3 Days	7 Days	14 Days	21 Days	28 Days
Var1	2212,35	2180,29	2189,72	2184,06	2187,83
Var2	2030,08	2006,82	2018,77	2022,54	2014,37
Var3	1979,8	1962,2	1977,28	1972,26	1974,14
Var4	2155,78	2147,55	2133,15	2111,78	2099,84
Var5	2256,34	2250,68	2251,94	2245,03	2236,23

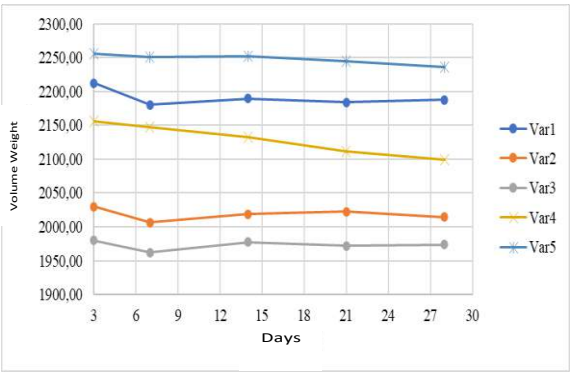

Figure 2. Graph of volume weight vs age of pervious concrete

From the table, it can be seen that the pervious concrete from each variation were taken from 15 specimens that had been made, which resulted in an average weight/volume weight of concrete between 1,974.14 – 2,236.23 kg/cm3 at the age of 28 days. It can be seen from this that the weight of pervious concrete is lighter than normal concrete in general and there is also the same where normal concrete is limited to a weight of 2,200-2,500 kg/cm3. The weight of this pervious concrete will decrease along with the increase in the age of the concrete.

3.3.3. Compressive Strength Test

The results of the compressive strength test of pervious concrete that have been tested for cylindrical specimens with a diameter of 15 cm and a height of 30 cm for each age obtained the following data:

Table 9 Average compressive strength by age

Variasi	Avarage Compressive Strength (MPa)				
	3 Hari	7 Hari	14 Hari	21 Hari	28 Hari
Var1	10	11,26	18,13	19,11	20,09
Var2	22,78	37,33	45,33	45,78	46,98
Var3	15,78	15,89	21,2	21,42	21,64
Var4	18,62	23,87	27,44	32,18	34,44
Var5	20,67	25,17	27,67	27,33	27,72

From the table it can be seen that the pervious concrete of each variation was taken from 15 specimens that had been made, which resulted in an average compressive strength of 28 days between 20.09 - 46.98 MPa. From the results obtained, the greatest compressive strength is the variation 2 by using mixed stone as much as 50% for stone 1/1 and 0.5/0.5. From the planning for 25 MPa which is close to the var5 variation, while for the var3 variation the compressive strength does not reach.
From the table above, we can see that with increasing age of the concrete, the compressive strength of the concrete will be stronger. This can be illustrated in the barcart image below.

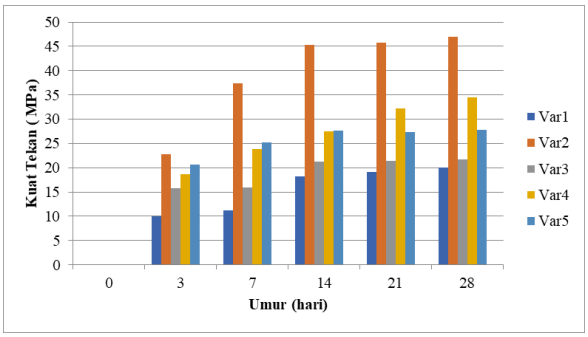

Figure 3. Barchart Compressive Strength Vs Age

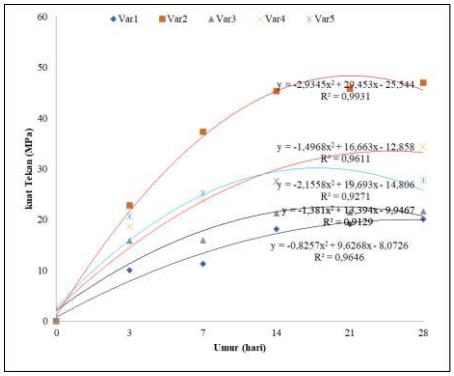

Figure 4. Graph of Compressive Strength Vs Age

For all variations that have been tested, the equation for the relationship between compressive strength and age is as follows:

Table 10. Equation of compressive strength vs. age of pervious concrete

Variation	Equition and Value R^2
Var1	$y = -1{,}381x^2 + 13{,}394x - 9{,}9467$ $R^2 = 0{,}9129$
Var2	$y = -2{,}9345x^2 + 29{,}453x - 25{,}544$ $R^2 = 0{,}9931$
Var3	$y = -0{,}8257x^2 + 9{,}6268x - 8{,}0726$ $R^2 = 0{,}9646$
Var4	$y = -1{,}4968x^2 + 16{,}663x - 12{,}858$ $R^2 = 0{,}9611$
Var5	$y = -2{,}1558x^2 + 19{,}693x - 14{,}806$ $R^2 = 0{,}9271$

where this is a strong relationship between y and x because R2 is close to 1 or the truth level is close to 1. From the above equation, we can use it as a reference to determine the strength of pervious concrete based on age.

3.3.4. Permeability Test

The results of the permeability test for pervious concrete that have been tested for cylindrical specimens with a diameter of 15 cm and a height of 30 cm for each variant obtained the following data:

Table 11. Permeability of the average age of 28 days

Variasi	Permeabilitas (cm^3/det)
	28 Hari (%)
Var1	0,1842
Var2	0,0973
Var3	0,4876
Var4	0,1148
Var5	0,0025

Based on the data from the table above, it was found that the permeability results were obtained in the Var3 variant, namely 1/1 cm stone without sieving with a permeability of 0.49 (cm^3/sec). For the smallest permeability is a mixture of stone size 0.5/0.5 cm without sieving.

3.3.5. Porosity Test

The results of the permeability test for pervious concrete that have been tested for cylindrical specimens with a diameter of 15 cm and a height of 30 cm for each variant obtained the following data:

Table 12. Porosity average age 28 days

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Variation	Porosity
	28 Days (%)
Var1	23,41
Var2	23,88
Var3	23,56
Var4	23,81
VVar5	23,24

Based on the data from the table above, it was found that the best proportion results were obtained in the Var2 variant, namely a mixed stone of 0.5/0.5 and 1/1 cm with a porosity of 23.88%. which is the more pervious the concrete will be easier to absorb and drain the water that remembers it.

3.3.6 Tensile split strength test

The results of the split tensile test of pervious concrete that have been tested for cylindrical specimens with a height of 30 cm and a diameter of 15 cm for each variant obtained the following data:

Table 13. The average split tensile test results based on the age of 28 days

Variation	Split tensile strength (MPa)
	28 Days
Var1	8,97
Var2	19,05
Var3	10,16
Var4	19,13
Var5	16,03

Based on the data from the table above, it was found that the best split tensile strength results were obtained in the Var4 variant, namely 0.5/0.5 cm stone filtered with a porosity of 19.13 MPa. Thus, for split tension in pervious concrete, the average split tensile strength is 40.55 -57.82 % of its compressive strength. Thus, this pervious concrete has met the requirements for split tensile strength where the minimum split tensile required is 40 % compressive strength.

4. Conclusion

a. From the material analysis that has been carried out, a mix design is made for pervious concrete with a planned compressive strength of 25 MPa using the ACI 522R-10 standard. The following mixture was obtained:

Tabel 14. Composition of pervious concrete

Cement vol	382,61	Kg/m³
Water weig	114,4	Kg/m³
Coarse aggr	1480,73	Kg/m³
Silicafume 1	57,39	Kg/m³
Sikamen LN	7,65	Kg/m³
Total	2.027,86	Kg/m³

b. From above mixture above, the cylindrical with a diameter of 15 cm and a height of 30 cm with variations in the coarse aggregate used were manufactured and the results are as follows :

Table 15. Test Results for Pervious Concrete

No	Test Result	Variation				
		Var1	Var2	Var3	Var4	Var5
1	Slump (mm)	195	170	170	48	45
2	Volume weight (Kg/m³)	2,187.83	2,014.37	1,974.14	2,099.84	2,236.23
3	Permeability (cm^3/det)	0.184	0.097	0.488	0.115	0.003
4	Compression strength (MPa)	20.089	46.978	21.644	34.444	27.722
5	Tensile strength (MPa)	8.968	19.048	10.159	19.127	16.032
6	Porosity (%)	23.413	23.876	23.563	23.808	23.242

c. From the data above, the best composition of physical and mechanical properties is Variation Var2 where by using a mixture of 0.5/0.5 stone and 1/1 cm stone each as much as 50%. These results were re-analyzed to obtain a modified mix design for pervious concrete based on ACI 522R-10.

d. From the data above, the best composition of physical and mechanical properties is the variation Var2 that using a mixture of 0.5/0.5 stone and 1/1 cm stone each as much as 50%. These results were re-analyzed to obtain a modified mix design for pervious concrete based on ACI 522R-10. This is due to the planned compressive strength of 25 MPa while the results obtained are 46.978, an increase of 187.912% from the initial plan.

e. The initial hypothesis which states that the variation of aggregate affects the physical and mechanical properties of pervious concrete has been verified with the results of the research obtained.

f. Good aggregate used in the manufacture of pervious concrete is stone with a mixture of 1/1 cm and 0.5/05 cm.

5. REFERENCES

ACI 522R-10. (2010). ***Report OnPervious Concrete*. USA**: American Concrete Institute Committee 522.

ASTM International (2004). ASTM 2004 Volume 04.02 : ***Concrete and Aggregates***.

Abadjieva, T., Sephiri, P., (2000) : ***Investigations on Some Properties of No-Fines Concrete***, University of Botswana,

Anonim, 2004, ***CIP-38 Pervious Concrete, NRMCA (National Ready Mixed Concrete Association),*** Silver Spring, Maryland.

Anonim, SNI 03-1974-1990, **Metode Pengujian Kuat Tekan Beton**, Puslitbang Permukiman, Departemen Pekerjaan Umum.

. Civil Rights Data Collection. (1980). ***CRD-C 104-80 : Method of Calculation of The Fineness Modulus of Aggregate***. The U.S. Department of Education.

Cormac, Mac, F.C. (1967). ***Rational Proportioning of Preformed Foam Cellular Concrete***. ACI Material Journal.

Ferdian, Frandy and Makmur, Amelia. (2011). ***Studi Penelitian Komposisi Beton Berpori Dengan Variasi dan Persentase Bahan Admixture Terkait Nilai Kuat Tekan Beton Pada Aplikasi Sidewalk***. Laporan Penelitian.

Ginting Arusmalem, ***Kuat Tekan dan Porositas Beton Porous Dengan Bahan Pengisi Styrofoam***, Jurnal Teknik Sipil, Volume 11, no 2, oktober 2015, Yogyakarta

Harber, P.J., 2005, ***Applicability of No-Fines Concrete as a Road Pavement***, Research Project, Bachelor of Engineering, Faculty of Engineering and Surveying, University of Southern Queensland

Indrayadi; Sutandar, Erwin; Supriyadi, Asep; Salim, Doni; Elizabet. (2021). ***Beton berpori precast***, Jurnal Teknik sipil, Issn 14123573, Volume 21, no 2, edisi Desember 2021.

Kusuma Dwi, 2013, ***Keungulan Beton Non Pasir***, https://dwikusumadpu.wordpress.com/tag/keunggulan-beton-non-pasir/

Mulyono, Tri Ir, M.T. (2005). ***Teknologi Beton***. Fakultas Teknik, Universitas Negeri Jakarta.

Murdock, L.J, Brook, K.M, Hindarko. (2013). ***Bahan dan Praktek Beton*** *Edisi Keempat*. Erlangga : Jakarta

Nugraha, Paul & Antoni. (2007). **T*eknologi Beton*.** Penerbit ANDI : Yogyakarta.

Neville, A.M., Brooks, J.J., 2010, ***Concrete Technology***, Second Edition, Pearson Education Limited, Essex, England.

Obla, Karthik H. (2010). ***Pervious Concrete On Overview*.** **India**: The Indian Concrete Journal.

Raju, N. Khrisna. ***Design of Concrete Mixes***. Ramaiah Institute of Technology Bangalore : India

SK SNI S-04-1989-F : ***Spesifikasi Bahan Bangunan Bagian A***. Departemen Pekerjaan Umum.

SNI 03-1968-1990: ***Metode Pengujian Tentang Analisis Saringan Agregat Halus dan Kasar***. Departemen Pekerjaan Umum.

SNI 03-1969-1990: ***Metode Pengujian Berat Jenis danPenyerapan Air Agregat Kasar***. Departemen Pekerjaan Umum.

SNI 03-1973-1990 : ***Metode Pengujian Berat Isi Beton***. Departemen Pekerjaan Umum.

SNI 03-2491-2002 : ***Metode Pengujian Kuat Tarik Belah Beton***. Departemen Pekerjaan Umum.

SNI 03-4431-1997 : ***Metode Pengujian Kuat Lentur Normal Dengan Dua Titik Pembebanan***. Departemen Pekerjaan Umum.

Susilowati, Anni, S.T, M.Eng, 2013. ***Buku Kerja Uji Bahan 2***. Jurusan Teknik Sipil, Politeknik Negeri Jakarta.

Sutandar, Erwin; Ariyanto; Supriyadi, A;, Mashudi, (2021), ***The Effects of Cement Types on Pervious Concrete***. International Journal of Advances in Engineering and Management (IJAEM) Issn 2395-5252 Volume 3

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Study Of Productivity And Costs On The Implementation Method Of Foundation Work Using Precast Concrete Pile As A Substitute To The Use Of Wooden Pile Foundations In Low Rise Building (Housing)

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Abstract

The soil condition in Pontianak City is mostly soft soil and peat soil which causes the low bearing capacity of the soil. Various efforts have been made to increase the bearing capacity of the soil, such as the use of wooden pile (kayu cerucuk). With the limited availability of wooden pile, the use of precast piles is an alternative in increasing the bearing capacity of the soil on the foundations of buildings/housings in Pontianak City.

The purpose of this study is to compare the productivity and costs of using a wooden pile foundation measuring 12/15 cm with a length of 9-12 M against the use of a square precast concrete pile foundation measuring 15x15 cm2 with a segment length of 3-4 M at a depth of 12-20 M and a size of 12-20 M. 20x20 cm2 with a segment length of 6 M at a depth of 12-18 M in low-rise buildings in Pontianak City.

From the results of the study, it is known that the productivity and average cost of piling per M' in a 2-storey shophouse building with an alternative foundation using 12/15 cm cerucuk piles is 22.3 seconds/m' at a cost of Rp. 17,306.24, precast piles square 15 x 15 cm2 of 111.5 seconds/m' at a cost of Rp. 144,274,439 and precast square piles of 20 x 20 cm2 of 125.7 seconds/m' at a cost of Rp. 291,338,955. In a type 150 house building with an alternative foundation using 12/15 cm wooden piles of 18.05 seconds/m' at a cost of Rp. 17,185.58, precast square piles of 15 x 15 cm2 of 104.67 seconds/m at a cost of Rp. 143,890.04 and 20 x 20 cm2 square precast piles of 94.66 seconds/m' with a cost of Rp. 289,724.234. The cost of foundation work with alternative foundations using precast square piles of 15 x 15 cm2 is the most efficient both from the aspect of driving costs, overall costs and the cost of the unit load carried by the foundation.

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1. Introduction

The soil condition in Pontianak City is mostly soft soil and peat soil. This condition causes the low bearing capacity of the soil and has the potential to decrease the construction on it. Various efforts have been made to increase the bearing capacity of the soil, such as the use of wooden cones which can increase the bearing capacity of the main foundation for low-rise buildings (two-story buildings). With the limited availability of niches, the use of precast piles is an alternative in increasing the carrying capacity of the soil on the foundations of buildings/housings in Pontianak City.

Precast concrete can be made into piles with dimensions of 100x100 mm, 150x150 mm and 200x200 mm with segmental lengths of 3 to 5 meters. These precast piles can be staked using various kinds of piling tools that are commonly used now in Pontianak, only with a smaller capacity of the piling tool. In this research, a comparison of productivity and cost of implementation of work using precast piles will be carried out as a substitute for wooden pile foundations in increasing the bearing capacity of the soil in Pontianak City for low-rise buildings (two-story buildings). The fixing method is to use Rigging Drop Hammer and Tripod Hammer. Piling of wooden pile uses a Tripod Hammer with a pounding weight of 250 kg, while for rectangular precast piles using a Rigging Drop Hammer with a capacity of 500 kg for a size of 15 x 15 cm2 and a Rigging Drop Hammer with a capacity of 1000 kg for a size of 20 x 20 cm^2.

The purpose of this study was to conduct a study on the comparison of productivity and cost of using a wooden pile foundation measuring 12/15 cm with a length of 9-12 m against alternative uses of a square precast pile foundation measuring 15x15 cm2 with a segment length of 3-4 m at a depth of 12-20 m. and

the size of 20x20 cm2 with a segment length of 6 m at a depth of 12-18 m.

2. Literature Review

2.1. Definition of Foundation

The foundation is a lower structure that is under the ground, or a lower structure that is directly related to the ground which has a function to carry the load of the upper structure such as columns, beams, plates, etc. (Joseph E. Bowles, 1997). The function of the foundation is to lay the building and transmit the superstructure loads, both dead and live loads and external forces, to a sufficiently strong soil base. Analysis of the bearing capacity of the foundation has an important role so that this foundation work has sufficient carrying capacity to carry the load on it.

2.2. Types of Foundation

Types of foundations are divided into 2, namely shallow foundations and deep foundations:

1) Shallow foundation

Shallow foundations are foundations that are used at a depth of 0.8 – 1 meter. Because the carrying capacity of the soil is sufficient. The types of shallow foundations include brick rollag foundations, river stone foundations, well foundations, strip concrete slab foundations and mini drill foundations / strauss piles.

2) Deep foundation

In use for buildings with soft soil, wide-span buildings (having a column distance of more than 6 meters), and high-rise buildings. Inner foundations include bore piles, piles. Pile foundations or mini piles can be divided into several categories (Bowles, 1991) including: wood mini piles, concrete mini piles, steel mini piles and composite mini piles. According to the method of installation, mini pile foundations are divided into two major parts, namely: precast mini piles and cast-in-place piles. Precast mini pile is a mini file that is fromed and cast in a concrete form (formwork), then after it is strong enough it is lifted and planted. This precast mini pile according to the way of installation consists of the method of pounding, the way of vibration and the way of piling/pressure.

3) Tripod Drop Hammer and B Rig Drop Hammer.

In the installation of the pile into the ground, the pile is driven with a bat which can be a hammer, a vibrating bat or a bat that is only dropped and a hydraulic press bat.

Tripod Drop Hammer

A wooden tripod and a 250 kg hammer are commonly used in crevice driving. The tripod legs use a wooden recess which is longer than the recess to be installed, equipped with a pulley and a machine winch to pull the sling that lifts both the hammer and the recess to be installed. The wooden tripod hammer can only mount the recess in a straight line in the direction of gravity

B Rigging Drop Hammer

B Rigging Steel Pipe or B. rig is a tool commonly used for driving precast and prestressed concrete foundations in Pontianak, with dimensions up to 32 cm in both square, triangular and round sections. The size of the steel pipe rigging itself varies and the main material can be made of steel pipe for the tool class weighing 3 Tons with a height of 8m – 11m with a hammer weight of 500 kg to 750 Kg and for the tool class weighing 1.2 Tons with a height of 6m-8m with a hammer weight of 350kg to 500 kg and for a tool class of 450 Kg with a height of 4m-5m using a hammer weighing 150-250 Kg. In terms of choosing steel pipe rigging, it is adjusted to the dimensions of the piles to be installed. Shifting and moving this tool is done manually by pushing or pulling with the help of the built-in winch.

2.3. Pile Piling Method

The stages of pile foundation work are as follows;

a) Preparatory Work

- Put a mark and date when the pile was cast.
- Lifting / moving, the pile must be moved / lifted very carefully to avoid cracking or damage
- Plan the final pile set, to determine at what depth pile driving can be stopped, based on soil data and data on the last number of strokes.
- Plan the driving sequence, taking into account the ease of maneuvering of the tool.
- Determine the stake with the Theodolith and mark it with a stake.
- Piling can be temporarily stopped for the next connection of rods if the level of the pile head has reached the ground level while the expected level of soil friction has not been reached.

b) Pole connection process:

- The mast is lifted and the head of the mast is mounted on the helmet as was done on the first rod.
- The lower end of the pile is placed above the head of the first pile so that the sides of the connecting plate of the two piles have coincided and stick together.
- Welded joints are coated with anti-corrosion
- The weld joint is coated with anti-rust.
- Finished connection, driving can be continued as was done in the first rod. Splicing can be repeated until it reaches the specified hard soil depth.
- Pile driving can be stopped when the bottom end of the pile has reached the specified hard soil layer/final set.
- Cutting the pile at the cut off level that has been determined.

c) Piling Process

- The piling tool is placed in such a way that the hammer axle falls on a predetermined stake.
- The mast is lifted at the lift point that has been provided in each hole.
- The pole is erected beside the driving lead and the head of the pole is mounted on a helmet

that has been covered with wood as a protector and handle for the head of the pole.

- The lower end of the pole is carefully positioned above the specified stake.
- The vertical adjustment of the pole is done by adjusting the length of the backstay while checking with a waterpass so that a truly vertical position is obtained. Before starting driving, the bottom of the pile is clamped with the center gate at the base of the driving lead so that the pile position does not shift during driving, especially for the first pile.
- Piling begins by lifting and dropping the hammer continuously onto the helmet mounted above the head of the pile.

d) Quality Control

- The entire surface of the pole is not damaged or cracked.
- The age of the concrete has met the requirements.
- The pile head must not be cracked during driving.
- The new piling can be stopped if the final set has been reached according to the calculation.

2.4. Pile Bearing Capacity From Sondir Results

Sondir or Cone Penetration Test (CPT) is highly considered the role of geotechnical because it is very fast, simple, economical and the test can be trusted in the field with continuous measurement of the subgrade surface. CPT or sondir can also classify soil layers and can estimate the strength and characteristics of the soil. In planning the mini pile foundation (pile), soil data is very necessary in planning the bearing capacity of the pile to determine the ultimate bearing capacity of the pile. The ultimate bearing capacity is determined by the following equation:

Qu = Qb + Qs

= qb.....(2.1)

where:

Qu = Pile's ultimate axial bearing capacity
Qb = Bearing capacity at the end of the pile
Qs = Skin resistance capacity.
qb = Bearing capacity at the end of the pile unit area
Ab = Area at the end of the pole.
F = Unit of skin resistance unit area
As = Pile skin area

In determining the ultimate axial bearing capacity (Qu) the Aoki and De Alencar methods are used. Aoki and Alencar proposed to estimate the ultimate bearing capacity from Sondir data. The end bearing capacity of the unit area (qb) is obtained as follows :

$$q_b = \frac{q_{ca}\ (base)}{F_b} \quad \text{..... (2.2)}$$

where :

qca (base) = The average cone resistance is 1.5D above the pile tip, 1.5D below the pile tip and Fb is an empirical factor depending on the soil type. The skin resistance per unit area (f) is predicted as follows:

$$F = q_c\ (side)\ \frac{a_s}{F_s} \quad \text{.....(2.3)}$$

where:

q_c (side) = The average cone resistance in each layer along the pile.
Fs = Empirical factors of skin resistance that depend on the type of soil.
Qs = Skin resistance capacity.
Fb = Empirical factor of pile end resistance which depends on the type of soil.

In general, the value of s for sand = 1.4 percent, the value of s for silt = 3.0 percent and the value of s for clay = 1.4 percent.

To calculate the carrying capacity of the mini pile based on the data from the sondir test, it can be done using the Meyerhoff method.

The ultimate bearing capacity of the pile foundation is expressed by the formula:

Qult = (qc x Ap)+(JHL x K11.....(2.4)

where:

Qult = Carrying capacity of single mini pile.
qc = Prisoners end sondir.
Ap = The cross-sectional area of the pile
JHL = The number of adhesive barriers
K11 = Pole circumference

The bearing capacity of the foundation permit is expressed by the formula:

$$Qijin = \frac{q_c\ A_c}{3} + \frac{JHL\ x\ K_{11}}{5}$$

where;

Q_{ijin} = Carrying capacity
JHL = Number of adhesive resistance
K11 = Perimeter of the pile

2.5. Definition of Productivity

Productivity in construction work can be interpreted as a comparison between output (production results) to inputs (production elements: labor, materials, equipment, management and time.

Productivity = (output / input x time}

So if the input is getting smaller and the output is getting bigger than the productivity index will be large, so the productivity is getting higher. The smaller the input and the greater the output obtained, it becomes a benchmark for productivity.

2.6. Definition of Costs in Construction Works

Cost analysis in construction projects is often referred to as work unit price analysis (AHSP) which is a method of calculating the unit price of construction work which is described in multiplying the need for building materials, work wages, and equipment with building prices, standard wages for workers and rental/purchase prices. equipment to complete per unit

of construction work. The amount of the price per unit of work depends on the unit price of materials, the unit price of wages and the unit price of tools.

2.7. Research methods

The method used in this research belongs to the type of comparative research because the results of the data processing of this research will be compared with each other to find out the advantages and disadvantages of each object to be studied according to the objectives to be achieved.

2.8. Research Location and Time

The research location is in Pontianak City, namely the Jawi River and Parit Haji Husen II. The case studies taken are foundation work on a 2-storey shophouse building located on the Jawi River and a Type 150 (two-storeys) house building located in Parit Haji Husen II. This research was conducted for 4 (four) months.

2.9. Research Stages and Procedures

The stages in this research can be seen in the following flow chart:

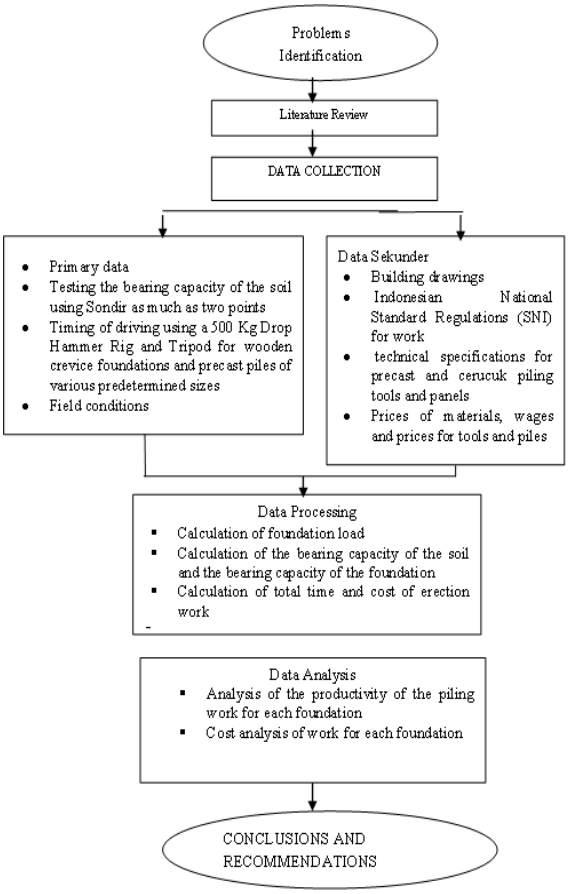

Figure 2.1. Research Flowchart

3. Results And Discussion

3.1. Productivity Analysis of Pile Piles Cerucuk and Precast Piles

The productivity of the driving time per m' pile foundation (per point of the pile group) is obtained from the total driving time per pile group divided by the total pile length in the pile group. The productivity of the average piling time of the entire building is the total driving time of the entire pile divided by the total length of the pile. The driving time consists of tool shear time/tool preparation, penetration time and pile preparation time.

Productivity of the results of piling wooden pile foundations and precast pile foundations of various types and sizes of piles per pile group and productivity of the overall average value of pile foundations in 2-storey shop houses and type 150 houses can be seen in table 3.1 and table 3.2 below:

Table 3.1. Productivity of Cerucuk Pile and Precast Pile Per Group of Piles and Average Value per Pile in 2-Story Ruko Building Location Jawi River

No.	Building	Description		Dimension				Time amount per group	Produktivity per point
		Pile Cap Number	Pile Cap	Pile Number	Cross section	Length	Depth		Second/meter
1	Ruko 2 Lantai	10	P1	16	Dec-15	11,5 M	11,5 M	3095.27	16.82
		2	P2	20	Dec-15	11,5 M	11,5 M	3869.09	16.82
		3	P3	25	Dec-15	11,5 M	11,5 M	4836.36	16.82
		8	P4	48	10-Dec	3,6 M	3,6 M	5493.82	31.79
2	Ruko 2 Lantai	8	P1	1	□15x15	4 M	16 M	1743.27	108.95
		2	P2	2	□15x15	4 M	16 M	3486.54	108.95
		8	P3	3	□15x15	4 M	16 M	5229.81	108.95
		3	P4	4	□15x15	4 M	16 M	6973.09	108.95
		2	P5	5	□15x15	4 M	16 M	8716.36	108.95
3	Ruko 2 Lantai	8	P1	1	□20x20	6 M	18 M	1961.18	122.57
		8	P2	2	□20x20	6 M	18 M	3922.36	122.57
		4	P3	3	□20x20	6 M	18 M	5883.54	122.57
		3	P4	4	□20x20	6 M	18 M	7844.72	122.57

Tabel 3.2 Productivity of Cerucuk Piles and Precast Piles Per Group of Piles and Average Value per Pile in Type 150 House Buildings Locations of Parit Haji Husen II

No.	Building	Description		Dimension				Time amount Per group	Produktiviy Per Point
		Number of Pile Cap	Pile Cap	Num. of Pile	Section	Lenght	Depth		Second per meter
1	House type 150	11	P1	4	Dec-15	11,5 M	11,5 M	773.82	16.82
		4	P2	6	Dec-15	11,5 M	11,5 M	1160.73	16.82
		6	P3	9	Dec-15	11,5 M	11,5 M	1741.09	16.82
		6	P4	12	Dec-15	11,5 M	11,5 M	2321.45	16.82
		4	P5	16	Dec-15	11,5 M	11,5 M	3095.27	16.82
		2	P6	20	Dec-15	11,5 M	11,5 M	3869.09	16.82
3	House type 150	12	P1	1	□15x15	4 M	12 M	1307.45	81.72
		2	P2	1	□15x15	4 M	16 M	1743.27	108.95
		5	P3	1	□15x15	4 M	20 M	2179.09	136.19
		5	P4	2	□15x15	4 M	16 M	3486.54	108.95
		4	P5	2	□15x15	4 M	16 M	3486.54	108.95
		1	P6	3	□15x15	4 M	20 M	6537.27	136.19
		1	P7	4	□15x15	4 M	16 M	6973.09	108.95
		2	P8	5	□15x15	4 M	12 M	6537.27	81.72
4	House type 150	19	P1	1	□20x20	6 M	12 M	1307.45	81.72
		9	P2	1	□20x20	6 M	18 M	1961.18	122.57
		4	P3	3	□20x20	6 M	12 M	3922.36	81.72

Based on the data in the table above, it is known that the average driving time productivity value is as follows:

2-storey shophouse (location of Jawi River):

- The productivity of the average piling time for a 12/15 cm cone with a driving depth of 11.5 M and a pile 10/12 cm with a depth of 3.6 M is 22.3 seconds/m'
- The productivity of the average driving time for precast square piles of 15 x 15 cm2 with a driving depth of 16 M (4 pole segments @ 4M) is 111.5 seconds/m'

- Productivity of the average driving time of 20 x 20 cm2 square precast piles with a driving depth of 18 M (3 pile segments @ 6M) is 125.7 seconds/m'
- Type 150 house (location of Parit Haji Husen II):
- Productivity of the average driving time for cerucuk piles is 12/15 cm with a driving depth of 11.5 M at 18.05 seconds/m'
- The average driving time productivity of 15 x 15 cm2 square precast piles with a driving depth of 12 M (3 pole segments @ 4M), 16 M (4 pole segments @ 4M) and 20 M (5 pole segments @ 4M) is 104 ,67 sec/m'

- The productivity of the average driving time for precast square piles of 20 x 20 cm2 at a driving depth of 12 M (2 pole segments @ 6M) , 18 M (3 pole segments @ 6M) is 94.66 seconds/m'

3.2. Calculation of Foundation Bearing Capacity and Foundation Work Cost

The type 150 house that is the reference in this study consists of 2 floors with a building area of 155.5 m2 (1st floor area = 105 M2 and 2nd floor area = 50.5 M2). The house is coupled to the left wall, so the load carried by the foundation is greater than the right side of the wall.

The shophouse building that is the reference in this study with a floor area of 8 x 18 m uses a slab roof. The plate is not designed to be able to carry the structural load of the next one floor building, especially at the back of the dak plate.

Through the application of Structural Analysis, with a combination of existing loads, the maximum axial pressure per tonne of each foundation point is obtained in Figure 3.1, Figure 3.2 and Figure 3.3 below:

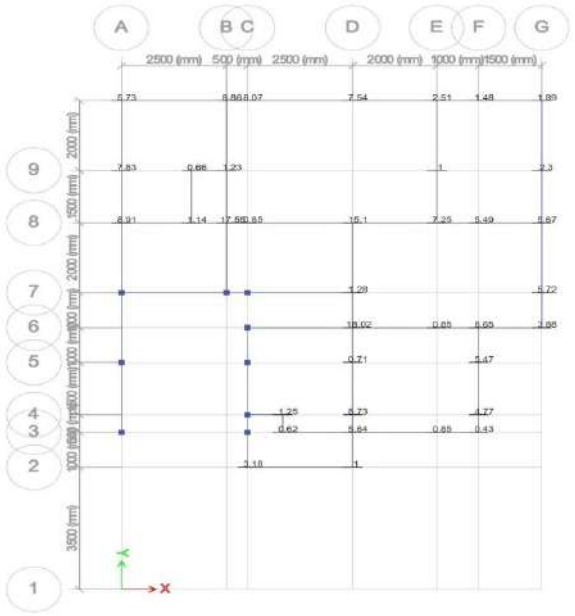

***Figure 3. 1**. Calculation results of the 150 type house foundation point*

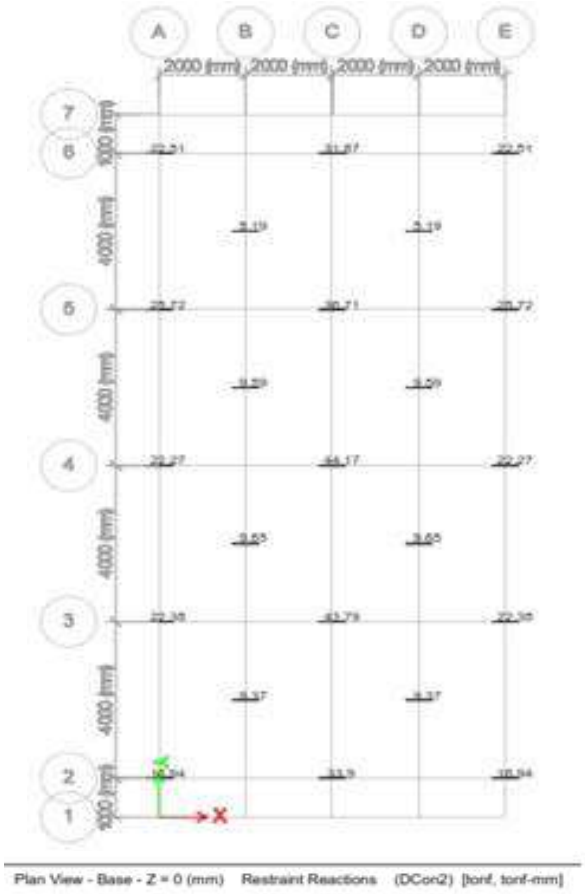

Figure 3.2. Loading of Concrete Foundation

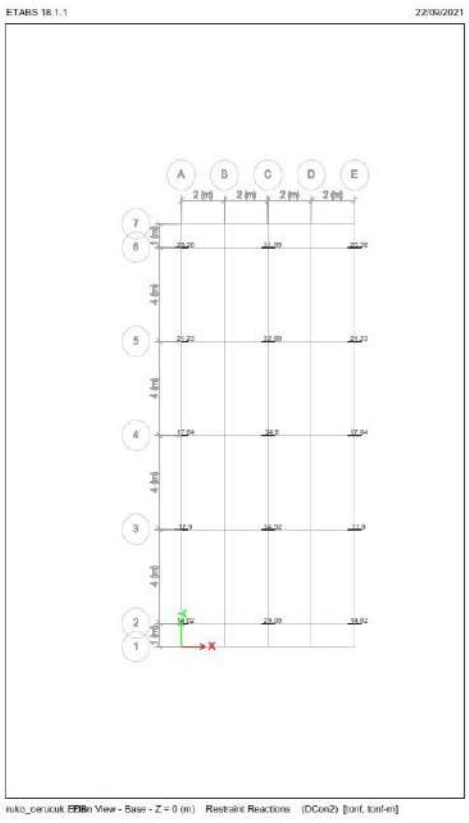

Figure 3.3. Cerucuk Foundation Loading Results

Based on the structural load that occurs at the foundation point from the results of the structural analysis calculation, the foundation bearing capacity calculation with various types and sizes of foundations (piles, pile caps and pedestal columns) is calculated. The bearing capacity of the foundation is the ability of the pile group in one foundation (Pile Cap) to bear the burden of the existing building structure. The bearing capacity of the foundation is calculated based on sondir data or CPT data. Based on CPT data, it is known that the type of soil at the location of the 2-storey Ruko building on the Jawi River and Type 150 House Building in Paris II is sandy loam. The water level in the 2-storey Ruko Building on the Jawi River is quite high, ie -0.6 m from the ground level, while the water level in the Type 150 house building in Parit Haji Husen II is rather low, i.e. -1.3 m above the ground.

By knowing the number and dimensions of the foundation, the cost of foundation work can be known. The cost calculation for the foundation work as a whole consists of excavation work, embankment work, pile work (procurement of poles, rental of tools and erection work) and concrete work for Pile Cap and pedestal columns (K225 concrete work, iron work and formwork work). By dividing the cost of the foundation by the magnitude of the load carried by the foundation, it is obtained the cost of the foundation of the foundation load (Rp/kg). The results of the recapitulation of the calculation of the load and bearing capacity of the foundation and the calculation of the cost of the foundation for all alternative uses of piles can be seen in the following table:

Tabel 3.3. Calculation results of bearing capacity of cerucuk pile foundations and precast piles for each pile group in a 2-storey shophouse building, Jawi River location

No.	Dimension of Pile								Dimension of Pilecap (cm)			Dimension of Pedestal Column (cm)			Calculation of Design Bearing Capacity		Bearing Capacity Need		
	Pile Cap	Num. of pile	Dimension	Pile Length	Depth	Num. Segement	Pile elevation	Material	Length	Width	Height	Length	Width	Height	Pile Bearing Capacity	Bearing Capacity of Pile Cap	Loading Test (Max)	QU	Control
															Kg	*Kg*	*Kg*	*Kg*	
1	P1	16	Dec-15	11,5 M	11,5 M	1	-0,6 M	Wood	180	180	50	30	30	110	2286.6	36585.5	20260.0	29236.6	25%
	P2	20	Dec-15	11,5 M	11,5 M	1	-0,6 M	Wood	225	225	50	30	30	110	2286.6	45731.9	31990.0	45960.3	0%
	P3	25	Dec-15	11,5 M	11,5 M	1	-0,6 M	Wood	270	270	50	30	30	110	2286.6	57164.9	34800.0	54873.6	4%
	P4	48	10-Dec	3,6 M	3,6 M	1	-0,6 M	Wood	-										
2	P1	1	□15x15	4 M	16 M	4	0 M	Concrete	45	45	25	30	30	100	9665.0	9665.0	9590.0	9927.5	-3%
	P2	2	□15x15	4 M	16 M	4	0 M	Concrete	75	45	30	30	30	100	9665.0	19330.0	16940.0	17399.0	11%
	P3	3	□15x15	4 M	16 M	4	0 M	Concrete	75	75	30	30	30	100	9665.0	28995.0	25720.0	26341.0	10%
	P4	4	□15x15	4 M	16 M	4	0 M	Concrete	75	75	30	30	30	100	9665.0	38660.0	36710.0	37331.0	4%
	P5	5	□15x15	4 M	16 M	4	0 M	Concrete	75	120	30	30	30	100	9665.0	48325.0	44170.0	45034.0	7%
3	P1	1	□20x20	6 M	18 M	3	0 M	Concrete	50	50	30	30	30	100	12880.0	12880.0	9590.0	9986.0	29%
	P2	2	□20x20	6 M	18 M	3	0 M	Concrete	50	110	30	30	30	100	12880.0	25760.0	22510.0	23122.0	11%
	P3	3	□20x20	6 M	18 M	3	0 M	Concrete	110	110	30	30	30	100	12880.0	38640.0	31870.0	32957.2	17%
	P4	4	□20x20	6 M	18 M	3	0 M	Concrete	110	110	30	30	30	100	12880.0	51520.0	44170.0	45257.2	14%

Table 3.4. Results of Calculation of Bearing Capacity of Cerucuk Pile Foundations and Precast Piles in Each Group of Piles in Type 150 House Building Locations of Haji Husen II Trench

No.	Dimension of Pile								Dimension of Pilecap (cm)			Dimension of Pedestal Column (cm)			Calculation of Design Bearing Capacity		Bearing Capacity Need		
	Pile Cap	Num. of pile	Dimension	Pile Length	Depth	Num. Segement	Pile elevation	Material	Length	Width	Height	Length	Width	Height	Pile Bearing Capacity	Bearing capacity of Pile Cap	Loading Test (Max)	QU	Control
															Kg	*Kg*	*Kg*	*Kg*	
1	P1	4	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	90	90	30	15	15	140	2258.6	9034.6	5274.5	7476.8	21%
	P2	6	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	110	110	40	15	15	130	2258.6	13551.9	8269.6	11676.5	16%
	P3	9	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	135	135	40	15	15	130	2258.6	20327.8	8852.0	13947.8	46%
	P4	12	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	156	156	50	15	15	120	2258.6	27103.8	16492.8	23518.2	15%
	P5	16	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	180	180	50	15	15	120	2258.6	36138.4	20241.7	29599.9	22%
	P6	20	Dec-15	11,5 M	11,5 M	1	-1,3 M	Wood	180	225	50	15	15	120	2258.6	45173.0	26613.2	38304.2	18%
2	P1	1	□15x15	4 M	12 M	3	0 M	Concrete	45	45	20	15	15	20	4810.3	4810.3	2300.0	2408.0	100%
	P2	1	□15x15	4 M	16 M	4	0 M	Concrete	45	45	20	15	15	20	6482.6	6482.6	3180.0	3288.0	97%
	P3	1	□15x15	4 M	20 M	5	0 M	Concrete	45	45	20	15	15	20	12468.0	12468.0	7990.0	8098.0	54%
	P4	2	□15x15	4 M	16 M	4	0 M	Concrete	45	90	25	15	15	15	6482.6	12965.1	9630.0	9881.1	31%
	P5	2	□15x15	4 M	16 M	4	0 M	Concrete	45	90	25	15	15	15	6482.6	12965.1	10080.0	10331.1	25%
	P6	3	□15x15	4 M	20 M	5	0 M	Concrete	90	90	25	15	15	15	12468.0	37404.0	30010	30504.1	23%
	P7	4	□15x15	4 M	16 M	4	0 M	Concrete	90	90	25	15	15	15	6482.6	25930.3	23600	24094.1	8%
	P8	5	□15x15	4 M	12 M	3	0 M	Concrete	125	90	25	15	15	15	4810.3	24051.4	21100	21783.1	10%
3	P1	1	□20x20	6 M	12 M	2	0 M	Concrete	50	50	30	15	15	10	8226.7	8226.7	6050.0	6235.4	32%
	P2	1	□20x20	6 M	18 M	3	0 M	Concrete	50	50	30	15	15	10	15573.3	15573.3	10080.0	10265.4	52%
	P3	3	□20x20	6 M	12 M	2	0 M	Concrete	110	110	30	15	15	10	8226.7	24680.0	20010.0	20886.6	18%

Table 3.5 Costs of Pile Foundation Work Cerucuk and Precast Piles With Various Dimensions and Depths of Embroidery in a 2-storey Shophouse Building, Jawi River Location and Type 150 House Building, Parit Haji Husen II Location

No	Building	Number	No.	Number of Pile	Dimension	Pile Length	Depth	Total cost of Foundation per pile group	Cost per Location	Cost per kg of foundation load
								Rp	Rp	Rp
1	2 Storeys Shophoou se	10	P1	16	Dec-15	11,5 M	11,5 M	133,535	262,544,138.13	365
		2	P2	20	Dec-15	11,5 M	11,5 M	38,762		423,8
		3	P3	25	Dec-15	11,5 M	11,5 M	80,251		467,95
		8	P4	48	10-Dec	3,6 M	3,6 M	9,994,		81,08
2	2 Storeys Shophous e	8	P1	1	□15x15	4 M	16 M	26,015	166,808,028.87	336,47
		2	P2	2	□15x15	4 M	16 M	11,750		303,95
		8	P3	3	□15x15	4 M	16 M	68,717		296,25
		3	P4	4	□15x15	4 M	16 M	32,693		281,89
		2	P5	5	□15x15	4 M	16 M	27,630		285,88
3	2 Storeys Shophous e	8	P1	1	□20x20	6 M	18 M	50,723	293,468,584.47	492,27
		8	P2	2	□20x20	6 M	18 M	97,109		471,22
		4	P3	3	□20x20	6 M	18 M	74,230		480,27
		3	P4	4	□20x20	6 M	18 M	71,405		461,99
4	House type 150	11	P1	4	Dec-15	11,5 M	11,5 M	28,289	226,243,219.35	343,97
		4	P2	6	Dec-15	11,5 M	11,5 M	17,507		374,84
		6	P3	9	Dec-15	11,5 M	11,5 M	38,385		458,68
		6	P4	12	Dec-15	11,5 M	11,5 M	58,542		414,87
		4	P5	16	Dec-15	11,5 M	11,5 M	51,519		435,14
		2	P6	20	Dec-15	11,5 M	11,5 M	31,999		417,7
5	House type 150	12	P1	1	□15x15	4 M	12 M	24,299	133,673,822.19	420,96
		2	P2	1	□15x15	4 M	16 M	5,200,		401,15
		5	P3	1	□15x15	4 M	20 M	15,880		254,74
		5	P4	2	□15x15	4 M	16 M	26,296		405,65
		4	P5	2	□15x15	4 M	16 M	21,037		405,65
		1	P6	3	□15x15	4 M	20 M	9,869,		263,87
		1	P7	4	□15x15	4 M	16 M	10,445		402,83
		2	P8	5	□15x15	4 M	12 M	20,644		429,17
6	House tyoe 150	19	P1	1	□20x20	6 M	12 M	75,388	177,046,345.50	482,31
		9	P2	1	□20x20	6 M	18 M	51,355		366,41
		4	P3	3	□20x20	6 M	12 M	50,302		509,55

Based on the results of the calculation table above, it is known that the cost of the pile work is as follows:

2-storey shophouse (location of Jawi River):

- The amount of work costs for 12/15 cm cerucuk piles with a driving depth of 11.5 M is Rp. 199.021.72 or Rp. 17.306.24/M' and the total cost of foundation work is Rp. 262,544,138.13. The unit cost of the load is IDR 418.92 per kg
- The amount of the work cost for square precast piles of 15 x 15 cm2 with a driving depth of 16 M (4 pole segments @ 4M) is Rp. 2,307,959.02 or Rp. 144,274,439/M' and the total cost of foundation work is Rp. 166.808,028.87. The cost of the unit load is IDR 300.89 per kg
- The amount of work costs for square precast piles of 20 x 20 cm2 with a driving depth of 18 M (3 pole segments @ 6M) is Rp. 5,244,101.19 or Rp. 291,338,955 / M' and the total cost of foundation work is Rp. 293,468,584.47. The unit cost of the load is IDR 476.44 per kg

Type 150 house (location of Parit Haji Husen II):

- The amount of work costs for 12/15 cm cerucuk piles with a driving depth of 11.5 M is Rp. 197,634.19 or Rp. 17,185.58/M' and the total cost of foundation work is Rp. 226,243,219.35. The unit cost of the load is IDR 407.53 per kg
- The amount of work costs for precast square piles of 15 x 15 cm2 at a driving depth of 12 M (3 pole segments @ 4M) is Rp 1,726,680.48, at a driving depth of 16 M (4 pile segments @ 4M) is Rp 2,302,240.65'and at a driving depth 20 M (5 pole segments @ 4M) for Rp. 2,877,800.81. The cost of pile work per M' is Rp. 143,890.04 and the total cost of foundation work is Rp. 133,673,822.19. The unit cost of the load is Rp. 373 per kg.
- The amount of work cost for square precast piles of 20 x 20 cm2 at a driving depth of 12 M (2 pole segments @ 6M) is Rp. 3,476,690.81, at a driving depth of 18 M (3 pole segments @ 6M) is Rp. 5,215,036.21. The cost of pile work per M' is Rp. 289,724,234 and the total cost of foundation work is Rp. 177.046,345.50. The unit cost of the load is Rp. 452.75 per kg.

The cost of a cerucuk foundation is higher than that of precast piles due to the placement of the piles below the very low water table (-1.3 m from the surface) which causes an increase in excavation costs, fill costs and concrete costs (pile caps and pedestal columns) on pile foundations. small.

4. CONCLUSION

Based on the results of the analysis and discussion that has been carried out, the following conclusions can be drawn:

a. The productivity of the average piling time in a 2-storey shophouse building with an alternative foundation using 12/15 cm cerucuk piles is 22.3 seconds/m' with a pile work cost per M' of Rp 17,306.24, square precast piles 15 x 15 cm2 of 111.5 seconds/m' with a pile work cost per M' of Rp. 144,274.439 and a 20 x 20 cm2 square precast pile of 125.7 seconds/m' with a pile work cost of Rp. 291,338,955. The productivity of the piling time in a type 150 house building with an alternative foundation using 12/15 cm cerucuk piles is 18.05 seconds/m' with a pile work cost per M' of Rp 17,185.58, precast square piles of 15 x 15 cm2 of 104 ,67 seconds/m with the cost of pile work per M' of Rp. 143,890.04 and 20 x 20 cm2 of square precast piles of 94.66 seconds/m' with the cost of piling work per M' of Rp 289,724,234.

b. The productivity of the pile foundation erection time in the type 150 house building is higher than the 2-storey shophouse building. The contributing factor is the ground water level in the Type 150 House building is lower than the 2-storey Ruko building and the number of segments on the concrete piles is less so that the lifting time and connection time are faster.

c. The total cost of foundation work on a 2-storey shophouse with an alternative foundation using 12/15 cm cerucuk piles is IDR 262,544,138.13, 15 x 15 cm2 square precast piles are IDR 166,808,028.87 and 20 x 20 cm2 square precast piles are 293,468,584.47. The total cost of foundation work on a type 150 house with an alternative foundation using 12/15 cm cerucuk piles is IDR 226,243,219.35, 15 x 15 cm2 square precast piles of IDR 133,673,822.19 and 20 x 20 cm2 square precast piles of IDR 177.046,345.50.

d. The cost of foundation work is based on the load carried by the foundation on a 2-storey shophouse building with an alternative foundation using 12/15 cm cerucuk piles of IDR 418.92 per kg, 15 x 15 cm2 square precast piles of IDR 300.89 per kg and 20 x 20 cm2 square precast piles of IDR 476.41 per kg. The cost of foundation work is based on the load carried by the foundation on a type 150 house building with an alternative foundation using a 12/15 cm cerucuk pile foundation of IDR 407.53 per kg, 10 x10 cm2 square precast piles of IDR 359.07 per kg, piles precast square 15 x15 cm2 for IDR 373 per kg and precast square stake 20 x 20 cm2 for IDR 452.75 per kg

e. In 2-storey shop houses and type 150 house buildings, the cost of foundation work using 15 x 15 cm2 square precast piles is the most efficient, both from the aspect of driving costs, overall costs and the cost of the unit load carried by the foundation. In a 2-storey shopshouse building, the cost efficiency of the 12/15 cerucuk pile foundation is 37 % and that of the 20 x 20 cm2 square precast pile is 43 % . In the type 150 house, the cost efficiency of the 12/15 cerucuk pile foundation is 41% and the 20 x 20 cm2 square precast pile is 24.5%.

5. REFERENCES

Asianto (2005). **Manajemen Produksi untuk Jasa Konstruksi**. Jakarta: PT. Pradnya Paramita

Arifin. (2008). **Analisa Perbandingan Biaya Pelaksanaan Pondasi Tiang Pancang dan Bor Pile Jembatan Suramadu.** Jurnal Ilmiah Neutron, Vol.8, No.2, Agustus 2008: 1-13.

Ervianto, Wulfram I. (2005). **Teori Aplikasi Manajemen Proyek Konstruksi.** Andi, Yogyakarta.

Malla, D.A, Fitriah, Sarita, U. (2018). **Analisis Efisiensi Penggunaan Drop Hammer Pada Pembangunan Gedung Bulog.** Universitas Halu Oleo, Kendari

Puspita, D.A. (2016). **Analisa Produktivitas Alat Berat Diesel Hammer Dan Hydraulic Hammer Pada Pemasangan Pondasi Tiang Pancang Di Proyek Pembangunan Gedung 2 SMK 1 MUHAMMADIYAH Kepanjen Kabupaten Malang**. Universitas Muhammadiyah Malang, Malang.

Permen PUPR. (2016). **Pedoman Analisis Harga Satuan Pekerjaan Bidang Pekerjaan Umum**. Kementrian PUPR, Jakarta.

Soeharto, I. (2001). **Manajemen Proyek (dari konseptual sampai operasional)**. Jakarta: Penerbit Erlangga

Sardjono, H.S. (2007). **Pondasi Tiang Pancang**, Jilid I . Sinar Jakarta.

Santoso, Budi (2003). **Manajemen Proyek**. Guna Widya, Jakarta.

Sugiyono. (2014). **Metode Penelitian Pendekatan Kuantitatif, Kualitatif dan R&D.** Alfabeta, Bandung.

Widiasanti, I, Lenggogeni. (2013). **Manajemen Konstruksi**. Remaja Rosdakarya, Bandung.

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OVERVIEW OF OCCUPATIONAL HEALTH AND SAFETY IN TRANSPORTATION ACTIVITIES PT ANTAM (PT MEG CONTRACTOR PT ANTAM)

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Abstract

Occupational safety and health aim to create a safe and comfortable environment in carrying out activities or work. In PT ANTAM's bauxite transportation activities, there are still occupational safety and health risks. The purpose of this study was to determine the frequency rate, accident severity (Severity Rate), and Safe T Score in PT ANTAM's bauxite transportation activities. The research method used is a descriptive method, which is a research method that describes quantitative data according to the conditions in the field of bauxite transportation activities. The results of the study are (1) The results of the calculation of the frequency rate of 0 which indicate that there were no mining accidents in bauxite transportation activities in January-September 2019; (2) The result of the calculation of the severity rate (Severity Rate) of the accident is 0 which indicates the absence of the severity of the mining accidents that resulted in that month due to the absence of mining accidents that occurred in that month; (3) The results of the calculation of the safe T-score of 0 indicate the work accident control program does not show a significant change.

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1. Introduction

PT ANTAM, Tbk is a bauxite ore mining company in West Kalimantan. PT ANTAM, tbk is located in Tayan Hilir District, Sanggau Regency. PT ANTAM, Tbk applies the open cast mining method with a shovel and truck mining system. The stages of bauxite mining at PT ANTAM, Tbk consist of land clearing, Stripping topsoil and overburden, Digging, Loading, and Hauling Crude Bauxite (CBX), Stockyard ETO, washing, Stockyard EFO (exportable fine ore), and Export. PT ANTAM UBPB Kalbar has a contractor providing equipment, namely PT MEG. PT MEG provides transportation equipment and operators/drivers for bauxite transportation activities.

Transportation is the activity of moving or transporting bauxite ore deposits to stockpiles. The stages in transportation are trucks queuing at the loading point, then the transportation equipment is in the loading position, loading material, and transporting material to the stockpile(Kelvin et al., 2020). Transportation activities have the potential to cause work accidents. work accidents are defined as work-related events that can cause injury or illness (depending on the severity), death events, or events that can cause death (OHSAS, 2007). Many factors cause work accidents, including human error, environment, and machine error(Sihotang et al., 2019).

One of the efforts that can be made to minimize workplace accidents and improve the health and safety of mining workers while working is the management of Occupational Health and Safety (K3). OHS management is important in mining activities and needs to be considered by mining companies (Ardyanti et al., 2020). K3 management is a process of risk identification, evaluation, and tackling hazards in the workplace to reduce the risk of harm (Dimas et al., 2019). One of the OHS management that can be done by mining companies is to increase knowledge and increase supervision of OHS implementation by employees and mining workers. Knowledge improvement such as K3 training and K3 socialization. The socialization of the K3 program is expected to increase work productivity (Meilasari et al., 2021). In addition, an evaluation of the implementation of occupational safety and health (K3) also needs to be carried out (Enom et al., 2016). It aims to monitor and evaluate the risk of work accidents and control efforts.

To evaluate the risk of work accidents, it is necessary to calculate the frequency of work accidents (Frequency Rate), the severity of work accidents (Severity Rate), and the Safe T-Score. The FR calculation aims to find out how often work accidents occur in PT ANTAM's bauxite transportation activities. While the calculation of the severity of work accidents (Severity Rate) aims to find out how

severe the work accident at PT ANTAM is. Calculation of Safe T-Score is a statistical analysis to determine the performance of K3. Therefore, it is necessary to study the Frequency Rate (FR), Severity Rate (SR), and Safe T-Score in transportation activities. It is an early mitigation effort in minimizing the risk of work accidents in PT ANTAM's bauxite transportation activities.

2. Materials and Methods

The stages of the research carried out are as follows:

2.1. Literature review

Literature studies are carried out to collect references that can support research in the form of journals, theses, and other library sources.

2.2. Data collection

Research data consists of primary data and secondary data.

a. Primary data

Primary data in the form of:

a) Data on the number of hours worked for all employees

b) Work Accident Data

Data collection was carried out by observing in the field and conducting a documentation study of data about employees at the company PT ANTAM.

b. Secondary Data

The secondary data in this study is the coordinates of the IUP PT ANTAM

2.3. Processing and data analysis

Primary data and secondary data are then processed by calculating the value of Frequency Rate (FR), Severity Rate (SR) and Safe T score.

a. Frequency Rate (FR)

The frequency rate is the number of accidents for every one million human hours. The frequency rate is used to identify the number of victims of work accidents in a certain period per million workers. The calculation of the frequency rate (FR) for Loss Time Injury is the number of HWK injuries for every 1,000,000 working hours divided by the number of hours worked by all employees in that period (SNI 13-6618-2001). The calculation of the frequency level can be calculated by the following formula:

$$FR = \frac{X+Y+Z}{Q} \text{ x } 1{,}000{,}000 \quad \text{.....(1)}$$

Description:

X = Number of Minor Mining Accidents
Y = Number of Severe Mining Accidents
Z = Number of Fatality
T = Total Working Hours of All Employees

The Permenaker standard above in statistical calculations is by the ILO standard with the number 1,000,000, namely the number 1,000,000 = (50 weeks/year) x (40 hours/week) x 500 workers, so it can be said that the denominator figure of 1,000,000 is the same as the accident rate. per 500 (five hundred) workers(International Labour Organization, 2013).

The OSHA (Occupational Safety Health Administration) (OHSAS, 2007) version of the statistical calculation standard is 200,000 with the number 200.00 = (50 weeks/year) x (40 hours/week) x 100 workers, so it can be said that the denominator number 200,000 is the same as the number of accidents per 100 (one hundred) worker.

b. Severity Rate (SR)

The severity rate is the number of work accidents or lost working days due to work accidents for one million hours worked people (SNI 13-6618-2001, 2001). Severity rate calculation formula:

$$SR = \frac{W}{T} \text{ x } 1{,}000{,}000 \quad \text{.....(2)}$$

Description:

W = Lost Time Day

T = Total Working Hours of All Employees

c. Safe-T Score

The Safe T-Score is an indicator value to assess K3 performance. The formula for calculating the Safe T score is:

$$\text{Safe T Score} = \frac{H - I}{\sqrt{\frac{I}{1{,}000{,}000}}} \quad (3)$$

Description:

H = FR Current Month
I = FR Previous Month

The Safe T Score value indicates whether or not there has been a change in an event. The full interpretation of this score is as follows:

- Safe T-score between +2.00 to -2.00, meaning that the work accident control program did not show any significant change.
- If the safe T-score +2.00 means that the work accident control program has decreased.
- If the safe T-score of 2.00 means that the K3 program has improved or the OSH performance or there is something good that needs to be maintained (Sihotang et al.,).

The calculated data is then analyzed to find out whether there are efforts to improve control by the company in the event of a work accident

Pervious concrete consists of agglomeration of single-sized coarse aggregate covered with a thin cement paste layer of about 1.3 mm (Neville and Brooks, 2010). Based on ACI 522R-10 mix design for pervious concrete consists of: cement (270 - 415 kg), aggregate (1190 - 1480 kg), cement water

Pervious concrete consists of agglomeration of single-sized coarse aggregate covered with a thin cement paste layer of about 1.3 mm (Neville and Brooks, 2010). Based on ACI 522R-10 mix design for pervious concrete consists of: cement (270 - 415 kg), aggregate (1190 - 1480 kg), cement water factor (0.27 - 0.34), ratio of sand and gravel weight (0 to 1:1) by using chemical admixtures.

The addition of sand will reduce the pore content and increase the compressive strength. The use of non-sand concrete as a pavement material is very limited and has not been developed for certain applications. However, non-sand concrete has been widely used as a structural building material in Europe, Australia and the Middle East for more than 70 years (Macintosh et al., 1965, in Harber, 2005). The earliest use of pervious concrete occurred in England in 1852 with the construction of two dwelling houses and a sea grove 61 m long and 2.15 m wide (Francis, 1965, in Harber, 2005). The use of non-sanded concrete became much more widespread during the material shortage after World War II, for cast-in-place load-bearing walls for non-rise and multi-storey buildings.

The initial use of non-sand concrete was mainly for two-story structures, then it was developed for five-story buildings in the 1950s and continues to grow. In recent years, pervious concrete has been used as a load-bearing material in high-rise buildings of up to ten stories. The most remarkable use of pervious concrete was in Stuttgart, Germany where high-rise buildings were constructed using conventional

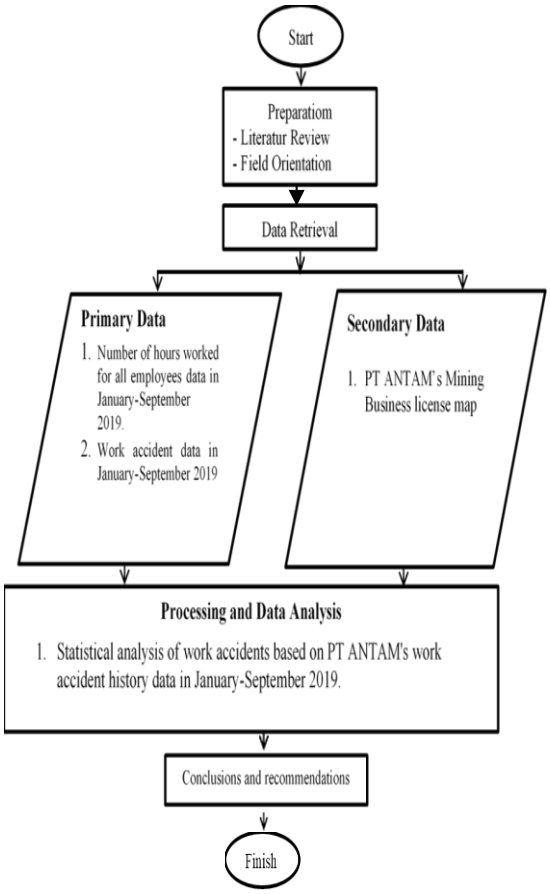

Fig 1. Research Flow Chart

3. Result and Discussion

3.1. Result

Table 1. Table of Work Accident Data PT ANTAM, tbk on transportation activities in January-September 2019

No	Month	Mine Accident			Number of Working Hours of Employees (T)	Lost Time Day (W)	Frequency Rate (FR)	Severity Rate (SR)
		Minor (X)	Severe (Y)	Fatality (Z)				
1.	January	0	0	0	129,291	0	0	0
2.	February	0	0	0	122,946	0	0	0
3.	March	0	0	0	154,923	0	0	0
4.	April	0	0	0	157,974	0	0	0
5.	May	0	0	0	166,607	0	0	0
6.	June	0	0	0	151,298	0	0	0
7.	July	0	0	0	208,010	0	0	0
8.	August	0	0	0	206,023	0	0	0
9.	September	0	0	0	211,694	0	0	0
	Total	0	0	0	1,508,766	0	0	0

Table 2. Safe T-Score Calculation Results for January-September 2019

No	Month Comparision	Safe T Score
1.	February-January	Undefined (No Accident)
2.	March-January	Undefined (No Accident)
3.	March-February	Undefined (No Accident)
4.	April-January	Undefined (No Accident)
5.	April-February	Undefined (No Accident)
6.	April-March	Undefined (No Accident)
7.	May-January	Undefined (No Accident)
8.	May-February	Undefined (No Accident)
9.	May-March	Undefined (No Accident)
10.	May-April	Undefined (No Accident)
11.	June-January	Undefined (No Accident)
12.	June-February	Undefined (No Accident)
13.	Juny-March	Undefined (No Accident)
14.	June-April	Undefined (No Accident)
15.	June-May	Undefined (No Accident)
16.	July-January	Undefined (No Accident)
17.	July-February	Undefined (No Accident)
18.	July-March	Undefined (No Accident)
19.	July-April	Undefined (No Accident)
20.	July-May	Undefined (No Accident)
21.	July-June	Undefined (No Accident)
16.	August-January	Undefined (No Accident)
17.	August-February	Undefined (No Accident)
18.	August-March	Undefined (No Accident)
19.	August-April	Undefined (No Accident)
20.	August-May	Undefined (No Accident)
21.	August-June	Undefined (No Accident)
22.	August-July	Undefined (No Accident)
23.	September-January	Undefined (No Accident)
24.	September-February	Undefined (No Accident)
25.	September-March	Undefined (No Accident)
26.	September-April	Undefined (No Accident)
27.	September-May	Undefined (No Accident)
28.	September-June	Undefined (No Accident)
29.	September-July	Undefined (No Accident)
30.	September-August	Undefined (No Accident)

a) Frequency Rate (FR)

Frequency Rate, which is the number of work accidents, aims to measure injuries due to mining accidents. The Frequency Rate (FR) of mining accidents in January-September 2019 is 0. It means that there were no mining accidents in that month. The results of the calculation of the frequency rate of mining accidents in January-September 2019 are as follows:

$$FR = \frac{(X+Y+Z)}{T} \text{ x } 1{,}000{,}000$$

$$FR = \frac{0}{0} \text{ x } 1{,}000{,}000 = 0$$

b) Severity Rate (SR)

The Severity Rate, a work accident severity number, aims to measure the severity of the accidents experienced in mining accidents. Based on the calculation results, the Severity Rate (SR) of mining accidents in January-September 2019 is 0. It indicates no severity of mining accidents that resulted in that month. Following are the results of the calculation of the Severity Rate of mining accidents in January-September 2019:

$$SR = \frac{W}{T} \text{ x } 1{,}000{,}000$$

$$SR = \frac{0}{0} \text{ x } 1{,}000{,}000 = 0$$

c) Safe T-Score

The calculated value of the safe T score is 0. The value of the Safe T score is in the range of +2.00 to -2.00. This value means that the work accident control program does not show significant changes. The following is an example of calculating the Safe T-Score from August to September:

$$\text{Safe T Score} = \frac{H - I}{\sqrt{\frac{I}{1{,}000{,}000}}}$$

$$\text{Safe T Score} = \frac{0 - 0}{0}$$

$$\text{Safe T Score} = 0$$

3.2. Discussion

There were no work accidents in the bauxite transportation activities of PT ANTAM, Tbk, in January-September 2019. It can be seen that there was no loss of working days for mining employees in January-September 2019. Based on the calculation results, it is known that the FR (frequency rate), SR (severity rate), and Safe T Score in January-September 2019 was 0. The mining company managed to achieve zero accidents in January-September 2019. The success of zero accidents is probably influenced by one of the factors, namely the environment. One example of environmental factors is the condition of the mine road/geometry of the mine road. Mining roads in the study area consist of one-way streets and two-way roads. Based on the results of the haul road geometry analysis at PT ANTAM, it is known that the road geometry meets the standards based on KEPMEN 1827 K; namely, the minimum haul road width is 12.005 m, the haul road width at the minimum bend is 13.34, and the haul road slope/grade is not more than 12%.

The success of zero accidents must be maintained by increasing occupational health and safety training for mining workers, especially for workers in the transportation area, increasing supervision of the implementation of occupational health and safety by mining workers, especially the use of personal protective equipment (PPE) while working. Rising routine inspections in the field to eliminate incidents that could result in negative impacts. For the emergence of an accident (mining accident) that results in employees' loss of working days.

4. Conclusion

The conclusions of this study are:

1. The frequency rate (FR) value in January-September 2019 is 0. It indicates no mining accidents and no injuries due to work in PT ANTAM's bauxite transportation activities.
2. The value of the accident severity rate (SR) in January-September 2019 is 0. This value means no mining accidents in transportation activities in that month, so the severity of the accidents produced did not exist.
3. The work accident control program in transportation activities shows no significant changes. It is based on the safe T score = 0.

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6. References

Ardyanti, R., Nirmala, A., & Meilasari, F. (2020). **Identifikasi Bahaya dan Risiko Menggunakan Metode Hirac Pada Aktivitas Tambang Bauksit di PT Aneka Tambang Tbk Tayan Hilir**. *Jurnal Elektronik Laut, Sipil, Tambang*, *7*(2), 1–9.

Dimas, Y. F., Sriyanti, & Dono, G. (2019). **Kajian Penerapan Sistem Manajemen Keselamatan dan Kesehatan Kerja (SMK3) serta Penggunaan Alat Pelindung Diri (APD) pada Tambang Andesit di PT. Mitra Multi Sejahtera Desa Mekarsari Kecamatan Cikalong Kulon Kabupaten Cianjur Jawa Barat**. Prosiding Teknik Pertambangan, 5(1), 167–175.

Enom, Sriyanti, & Zaenal. (2016). **Evaluasi Implementasi Kesehatandan Keselamatan Kerja (K3) Dalam Kegiatan Penambangan Batuan Andesit**. Evaluation Implentation of The Health and Workplace Safety (K3) in The Activities of. Peran Unisba Dalam Pemanfaatan Hasil Penelitian Untuk Pengembangan Dan Pemyebarluasan IPTEK Dan IMTAK Yang

Berkelanjutan Di Jawa Barat, 517–525. http://dx.doi.org/10.29313/pertambangan.v0i0.4413

International Labour Organization. (2013). **Occupational Health and Safety Means for Productivity**.

Kelvin, M., Purwoko, B., & Syafrianto, M. K. (2020). **Analisis Potensi Bahaya dan Pengendalian Risiko Pertambangan Batu pada Tahap Muat Angkut dan Dumping di PT. Sulenco Wibawa Perkasa Kabupaten Mempawah Provinsi Kalimantan Barat**. Jurnal PWK, Laut, Sipil, Tambang, 7(1), 1–9.

Meilasari, F., Sutrisno, H., Ariqah, R., Suwarni, L., Nirmala, A., & Wibowo, Y. H. W. R. (2021). **Kajian Dampak Kebisingan Akibat Aktivitas Pertambangan Di Area Washing Plant. Jurnal Kesmas (Kesehatan Masyarakat) Khatulistiwa**, 8(3),141.https://doi.org/10.29406/jkmk.v8i3. 3061.

OHSAS. (2007). OHSAS 18001:2007 **Sistem Manajemen Keselamatan dan Kesehatan Kerja - Persyaratan. In *Ohsas***.

Sihotang, O. S. R., Syafrianto, K., & Meilasari, F. (2019). **Tinjauan Kecelakaan Kerja Pada Area Stockpile Kalimantan Barat**. *JelAST*, *6*(1).https://doi.org/http://dx.doi.org/10.26418/jelast.v6i1.32166

SNI 13-6618-2001. (2001). ***Metode penghitungan tingkat kekerapan dan tingkat keparahan cedera akibat kerja di pertam bangan umum*.**

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National Road Slide Management With Cantilever Type Soil Retaining Wall

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Abstract

The title of this research is "National Road Avalanche Management With Cantilever Type Soil Retaining Wall". The background of the research is that the national road sta 20+700, section 041 or to be precise in Muaramais Village, Tambangan District, Mandailing Natal Regency, North Sumatra, is a landslide point that occurred around 2018. For this reason, in 2021, handling has been carried out in landslides with a cantilever type retaining wall. The dimensions of the cantilever are 15 meters long, 3.50 meters deep from the asphalt surface and 2.00 meters wide. Then, the upper wall thickness is 0.30 meters and the lower wall thickness is 0.40 meters. The purpose of this study was to calculate whether the cantilever type retaining wall is safe against overturning, sliding and soil bearing capacity.

The results of the research, that the cantilever type retaining wall is safe against overturning, because FS rolls = 4.65 ≥ FS = 2.00 and stability against shear is also safe, because FS shear = 1.96 ≥ FS = 1.50 and retaining walls safe against the bearing capacity of the soil, because the bearing capacity FS = 9.30 ≥ FS = 3.00

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handling, landslide, retaining wall, soil, cantilever

1. Introduction

This research is entitled "National Road Slide Management with Cantilever Type Soil Retaining Wall". The background of the research is that the national road sta 20+700, section 041 or to be precise in Muaramais Village, Tambangan District, Mandailing Natal Regency, North Sumatra, is a landslide point that has not been handled since the last 4 years. Then, the retaining wall at this location was previously of the gabion type (gabion) which gradually runs out of stones in the gabion, so that the condition of the landslide point is very dangerous for traffic users. This landslide actually occurred on the cliff side of the road and damaged part of the road along the 15 meter slope and 3.50 meter depth, eliminating the shoulder of the road. This landslide is one of the natural disasters that often hit hilly areas in the wet tropics (Hardiyatmo, 2012), so many factors cause slope landslides such as geological and hydrological conditions, topography, climate, and weather changes that lead to landslides.

For this reason, in the 2021 budget year, KDP 2.3 North Sumatra Province will handle landslides at this location, by holding back a cantilever type soil wall. In this study, the problem of handling landslides with a cantilever type retaining wall will be discussed as shown in Figure 1.

Figure 1. Cantilever type retaining wall
(Source : Project implementation in 2021)

Landslide handling at this location is used cantilever retaining wall made of reinforced concrete, therefore the dimensions of the stem and base slab are relatively thin. In addition to its own weight, this cantilever retaining wall relies on the weight of the soil mass above the base slab, to maintain its stability. This retaining wall is suitable for holding soil up to 8 meters high (SNI 8460:2017).

According to Erly Bahsan while giving a lecture on soil mechanics with the topic of earth retaining walls at the Department of Civil Engineering, University of Indonesia, which was uploaded on https://www.youtube.com, accessed 6 March 2022, that what must be considered for designing retaining walls. He took some of the points mentioned from Craig (2006), in designing retaining walls that must be considered are:

(1) Stability against overturning. So the wall must not be overturned due to the lateral soil force of the soil.
(2) The pressure at the base of the wall shall not exceed the ultimate capacity of the soil. This is like the principle of calculating shallow foundations, namely the tread of the walls is treated for shallow foundation calculations.
(3) Sliding, the wall must not be moved from its footprint, the base must not be shifted, and he said that these are 3 main points that must be considered in designing a retaining wall.

It was explained what would happen if the safety values were not met, if from the bolster side the design had to be changed, it meant that the gravity weight/gravity concept had not been fulfilled. The resisting moment cannot exceed the overturuning moment. To overcome the overturning moment, the resisting moment must be increased. How to enlarge it, one of which is to enlarge the design of the walls. Furthermore, he said, that if the shear stability is not met, the wall will slide and can be repaired with a shear key. A sliding lock can be made under the tread there is a kind of peg or resistance / wedge, so under the wall a kind of wedge / brake is placed so that the wall is not easily moved, it is called a shear key. In general, what must be considered in designing retaining walls is the stability of overturning, shearing, and the bearing capacity of the soil.

In this study, the handling of landslides on the national road sta 20+700, section 041 will be carried out by making a cantilever type retaining wall. This retaining wall is made of reinforced concrete. If at any time the question arises, is this retaining wall safe from landslides? Questions must be tried first with calculations, later it will be seen from the results of calculations whether the retaining wall is safe against overturning, sliding and soil bearing capacity.

2. Literature Review

2.1. Cantilever Retaining Wall Design

According to Hardiyatmo (2020), in general, the steps for calculating the design of retaining wall structures can be carried out as follows:

(1) Selected the shape of the retaining wall, including choosing the vertical wall dimensions, thickness and width of the foundation plate. For this purpose, Figure 2.1 can be used as a starting point.
(2) With known soil parameters, the forces acting on the base of the retaining wall foundation are calculated.
(3) Determine the location of the resultant forces acting. The location of the resultant is used to determine the stability of the retaining wall against the danger of overturning.
(4) Calculated factor of safety against overturning and sliding.
(5) Calculate the pressure that occurs at the base of the foundation. The maximum pressure must not exceed the allowable soil bearing capacity (qa).
(6) Designed the parts that make up the structure, such as calculating the dimensions and reinforcement of foundations and walls.

The cantilever wall parts consist of the wall, back foundation plate and front foundation plate. In each section it is designed like designing a cantilever structure. To design the foundation slab, the earth pressure that occurs at the base of the foundation is calculated first, ie by assuming a linear earth pressure distribution. The subgrade pressure due to the load of the retaining wall that occurs at the ends of the foundation plate is calculated as follows:

(1) If; $q = \frac{V}{B}\left(\pm\frac{6e}{B}\right) e \leq \frac{B}{6}$ .....(1)

(2) If; $q_{max} > \frac{2V}{3}$ (B-2e)e $> \frac{B}{6}$ .....(2)

where,

e = eccentricity (m)
B = Foundation width (m)
V = retaining wall selfweight (kN)
q = soil bearing capacity (kN/m^2)

If e < B/6, then the pressure on the wall to the ground that occurs is in the form of a trapezoid, while if e > B/6, then the pressure diagram is in the form of a triangle. The foundation slab is considered to be a cantilevered structure whose span is limited by the vertical portion of the retaining wall body.

2.2. Stability Against Rolling

Lateral stresses created by the backfill behind the retaining wall, tend to overthrow the wall with the center of rotation at the end of the forefoot of the foundation slab. This overturning moment is countered by the moment due to the self-weight of the retaining wall and the moment due to the weight of the soil above the foundation slab. The safety factor due to overturning (F), is defined as :

$$F_{guling} \leq \frac{\sum Mw}{\sum Mg} \quad \text{.....(3)}$$

F_{guling} = Safety factor against overturning
$F_{guling} \geq 2$
$\sum M_w$ = Resisting Moment
$\sum M_g$ = Overturning Moment

2.3. Stability against Shear

The force that resists the retaining wall will be resisted by the impact between the soil and the base of the foundation and passive earth pressure when in front of the embankment retaining wall. The safety factor against shifting is defined as follows:

$$Fgeser \leq \frac{\sum Rw}{\sum Ph} \quad \text{.....(4)}$$

For granular soil c = 0,
$\sum R_h$ = W x tg δ, with $\delta \leq \theta$
For soil with $\theta > 0$ and $c > 0$),
$\sum R_h$ = (cax B) + (W x tg δ), with $\delta \leq \theta$
$\sum R_h$ = Resistance of retaining wall to shear
W = Total weight of retaining wall (kN)
δ = angle of friction between the soil and the base of the foundation is usually taken (1/3 – 2/3) θ
ca = a_d x c = adhesi between the ground and the base of the wall (kN/m^2)
c = Subgrade cohesion (kN/m^2)
a_d = Adhesion factor
B = Foundation width (m)

2.4. Ultimate Bearing Capacity

The ultimate bearing capacity is calculated using the equations of Hansen (1970) and Vesic (1975) for inclined and eccentric loads:

$$qu = d_c \times i_c \times c \times Nc + d_q \times i_q \times D_f \times \gamma \times N_q + d_\gamma \times i_\gamma \times 0{,}5\ B_\gamma \times N_\gamma \quad \text{.....(5)}$$

where,
d_c, d_q, d_γ = depth factor
i_c, i_q, i_γ = load slope factor
B = actual base width (m)
γ = soil volume weight (kN/m^3)
Nc, Nc, N_γ = bearing capacity factors
The factor of safety against failure of the bearing capacity is defined:

$$F_{\text{Daya Dukung}} = \frac{qu}{q} \geq 3 \quad \text{.....(6)}$$

where,
q = stress due to structural load.
q_u = ultimate bearing capacity
F = the factor of safety against the bearing capacity of the soil is taken 3.

In the design, the width of the retaining wall foundation (B) should be made such that e < (B/6). This is intended so that the efficiency of the foundation is maximum and the foundation pressure difference at the ends of the toes of the wall is not large (to reduce the risk of wall collapse due to overturning).

Meanwhile, according to SNI 8460:2017 that the cantilever retaining wall is made of reinforced concrete, therefore the dimensions of the stem and base slab are relatively thin. In addition to its own weight, this cantilever retaining wall relies on the weight of the soil mass above the base slab, to maintain its stability. This retaining wall is suitable for holding high ground, up to 8 m.

Often the legs of this retaining wall are still sitting on poor soil, therefore sometimes soil reinforcement/remediation is needed to improve its bearing capacity. Soil reinforcement that is often used is by placing short piles, especially at the front, without being connected to the base slab, so that the pile does not experience shear failure.

NOTE – Figure 2 summarizes the initial approximate dimensions of the retaining wall for both the gravity type, cantilever type, and cantilever type with stiffeners, which are expressed as a function of the soil height H.

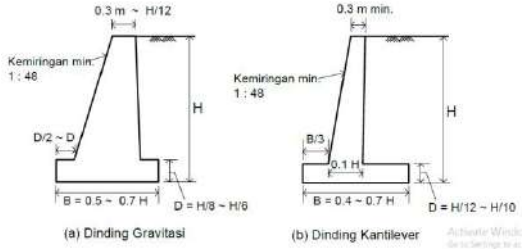

Figure 2. Dimensions of retaining walls (Source : SNI 8460 : 2017)

According to (Redana, 2009), the dimensions of the retaining wall to be built are known according to the needs in the field. The height limit for retaining walls made of stone is 3-4 meters, while for concrete walls it is 4-5 meters. Cantilever walls that are taller than 7 meters must use counterforts. Walls with a height of 7-9 meters should use an armature. The increase in wall height makes the wall uneconomical.

Cantilever walls are usually cast in place and stem, toe and heel sizes are designed to withstand maximum shear loads and bending moments. There are several factors that must be considered for the collapse of retaining walls, including stability against overturning, sliding, and settlement on the toe.

Meanwhile (Nakazawa, et al, 2000) argues, that retaining walls are buildings built to prevent the collapse of steep soil or slopes that are built in places where stability cannot be guaranteed by the slope of the soil itself, influenced by the conditions of the topographical description of the place. earthworks such as tackling or cutting the soil. In particular, if the road is built bordering a river or lake or marshy land, the retaining wall is built to protect the slope of the soil and complement the slope with a solid foundation.

The retaining walls such as reinforced concrete retaining walls with cantilever beams are composed of a longitudinal wall and a floor slab. Each acts as a cantilever beam and the stability of the wall is obtained by its own weight and the weight of the soil above the heel of the floor slab. Because this type of retaining wall is relatively economical and also relatively easy to implement, this type is also used in a wide range.

Each retaining wall must be checked for stability against overturning, lateral shear, and the bearing capacity of the soil. The safety factors required by SNI 8460:2017 are:

(1) Safe factor against rolling min 2
(2) Safety factor against shear min1.5
(3) The factor of safety to the minimum carrying capacity of 3

To calculate the soil pressure in this research is done analytically using the Rankine method. In this theory to determine the earth pressure on the wall in an active and passive state. Rankine did not examine a failure mechanism, but investigated the stress state of a particular soil element in the soil mass behind the

wall. Rankine does this based on the assumption that the walls are upright and there is no friction between the walls and the soil and also no pore water. Then the surface of the vertical plane is considered to be flat and the direction of the pressure force is with the plane of the ground surface.

In both the active and passive states, the soil is considered to have reached a state of failure or, in other words, in a state of "plastic equilibrium". In the active state, the vertical stress is the large principal stress and the horizontal stress (small principal stress) becomes the active Rankine stress a. The failure plane is found at an angle of 450+θ/2 to the horizontal. In the passive state, the horizontal stress, i.e. the passive Rankine pressure, becomes greater than the vertical stress so that it is a large principal stress. The failure plane now exists with an angle of 45-θ/2 vertical. (Wesley, 2012).

Considered a homogeneous and isotropic non-cohesive soil located in a semi-infinite space with a horizontal surface and a vertical retaining wall in the form of a perfectly smooth wall. To evaluate the active earth pressure and passive soil resistance, the boundary equilibrium conditions for an element in the soil with horizontal surface conditions and no shear stress in both vertical and horizontal planes are reviewed. It is assumed that the ground is held in the horizontal direction.

Under active conditions any soil element will be the same as the specimen in the triaxial apparatus under test with the application of reduced cell pressure, while the axial pressure remains. When the horizontal stress is reduced to a certain value, the shear strength of the soil will eventually fully develop and the soil will then fail. The horizontal force that causes this failure is the active earth pressure and the ratio of the horizontal and vertical pressures in this condition is the coefficient of active pressure or K_a. When expressed by the formula:

$$Ka = tg^2 (45 - \theta/2) \quad \text{.....(7)}$$

Now when the soil is compressed in its horizontal direction, any soil element will be in the same condition as the test specimen in a triaxial apparatus which is loaded until it collapses by increasing the cell pressure while the axial pressure remains constant. The comparative value of horizontal and vertical stresses in this condition is the coefficient of passive pressure or Kp (Hariyatmo, 2010). When expressed by the formula:

$$Kp = tg^2 (45 + \theta/2) \quad \text{.....(8)}$$

2.5. Lateral Earth Pressure on Wall

Figure 3 shows a retaining wall with non-cohesive fill such as sand (c = 0), with a volume weight of and an angle of friction in , and no groundwater. For the active Rankine position, the active earth pressure (pa) on the retaining wall at any depth can be expressed by;

$$p_a = z \gamma K_a \text{ ; untuk } c = 0 \quad \text{.....(9)}$$

The total active earth pressure (Pa) for a retaining wall of height H is equal to the area of the pressure diagram (Fig. 3.1a), i.e.:

$$Pa = \tfrac{1}{2} H^2 \gamma K_a \quad \text{.....(10)}$$

The distribution of earth pressure lateral to the retaining wall for Rankine's passive position is shown in Figure 3.1b. Passive earth pressure (pp) at any depth is given by;

$$P_p = z \gamma K_p \text{ ; for } c = 0 \quad \text{.....(11)}$$

Passive earth pressure at the base of the retaining wall:

$$Pp = H.\gamma.Kp \quad \text{.....(12)}$$

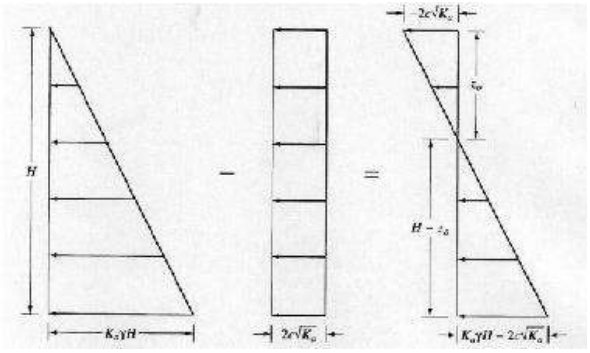

Figure 3. Diagram for Latrral Earth Pressure Distribution against Retaining Walls (Hardiyatmo, 2010)

Sometimes the backfill behind the retaining wall is affected by evenly distributed loads. By assuming an evenly distributed load q as a soil load with a thickness of hs with a certain volume weight , then the height of the soil layer hs = q/γ (Figure 4). The lateral earth pressure at depth hs from the assumed soil height (or at the fill soil surface) will be;

$$p_a = hs \gamma K_a \quad \text{.....(13)}$$

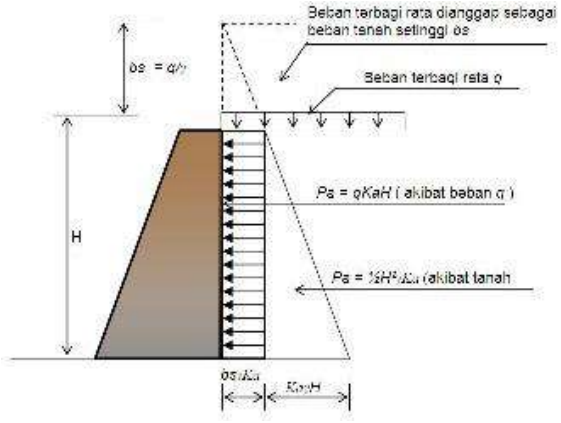

Figure 4. Lateral earth pressure due to evenly distributed load (Hardiyatmo, 2010)

So, due to this uniformly distributed load, the additional total active earth pressure on the retaining wall of height H can be expressed by the equation:

$$Pa = qH.Ka \quad \text{.....(14)}$$

The active soil pressure diagram due to this evenly distributed load will be in the form of a rectangle with height H and side width q K_a.

3. Research Method

The research procedure is as shown in Figure 5 below.

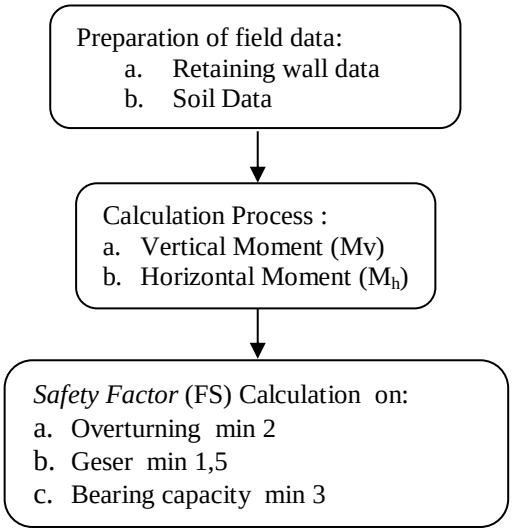

Figure 5. Research Procedure

To design this research, the stages of documentation of retaining soil walls were carried out, including:

(1) Stability against overturning

Calculation of stability against overturning begins by calculating the vertical moment (Mv) by dividing each part of the retaining wall, namely the weight of the concrete per meter multiplied by the distance from the center of gravity to point A. Next, add up the entire vertical moment ((Mv) that exists, and this is called the term resisting moment. Then, calculating the horizontal moment (Mh) is obtained from the value of the active pressure (pa) due to the soil itself and due to the load at the depth of the retaining wall (H) times the distance from the center of gravity to point A. Next, add up the overall horizontal moment (Mh) that exists, and this is called the term thrust moment.So, if the stability of the retaining wall is safe against overturning jika terpenuhi *Safety Factor*, FS=M_v/ M_h ≥ 2.

(2) Stability against sliding

Calculation of stability against sliding (sliding) begins by calculating the total vertical force of the retaining wall (Wv). Next, calculate the total horizontal ground force (Pa). So, if the stability of the retaining wall is safe against sliding (sliding) if the safety factor is metFS = Wv/Pa 1.5 (this formula applies if there is no friction angle (δ) between the retaining wall and the fill soil or the wall surface is considered perfectly smooth. Then the backfill is not cohesive (c = 0), (Rankine, 1857 in Hardiyatmo,2020).

(3) Stability against Soil Bearing Capacity

Calculation of the stability of the bearing capacity of the soil begins with calculating the bearing capacity of the soil (q_u). Which q_u is the bearing capacity based on the strength of the soil taken based on the longitudinal foundation of the formula (Terzaghi, 1943) i.e. q_u = c N_c + Df. γ N_q+ 0,5 B γ Nγ. Next, calculate the bearing capacity based on the retaining wall, namely the contact pressure distribution between the subgrade which is considered linear (q), then carrying capacity q = V/B + (1 ± 6e/B) if e =B/6. In the design, the width of the retaining wall foundation (B) should beThus, if the stability of the retaining wall is safe against the carrying capacity of the soil if the safety factor is met, FS = q_u/q ≥ 3.

3.1 Research Site

This research was conducted on the national road sta 20+700, segment 041 or to be precise in Muaramais Village, Tambangan District, Mandailing Natal Regency, North Sumatra, as shown in Figure 6 and Figure 7 below.

Figure 6. Map of research locations (Source ://www.google.com 2021)

Figure 7. Research location in Muaramais Village (Source : Project Implementation 2021)

3.2 Research Focus

The aspect studied in this study is to make efforts to handle landslides with cantilever type retaining walls. This cantilever wall will be calculated with the aim of whether the retaining wall is safe against overturning, sliding and soil bearing capacity.

4. Research Result And Discussion

4.1. Research Result

a. Retaining wall data
   H = 3,50 meter
   B = 2,00 meter

b. Soil data

γ_b = 18,80 kN/m^3 *(backfill)*
γ_t = 18,85 kN/m^3 (soil in situ)
θ = 29,74^0, Ka= 0,34
c = 0 *(backfill)*
c_1 = 22,35 kN/m^2 (soil in situ)
θ_1 = 29,24^0 (soil in situ), faktor Hansen: Nc = 28,41 and Nγ = 13,49

c. Rainforced Concrete Data

γ_c = 24 kN/m^3
f_c' = 30

d. The profile of the cantilever type retaining wall as shown in Figure 8 below:

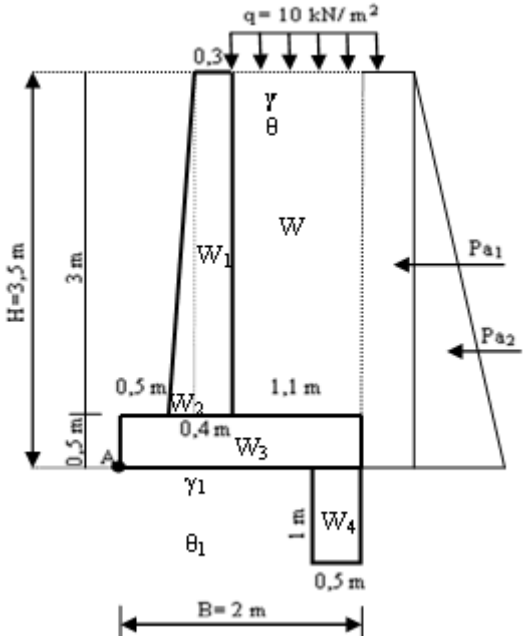

Figure 8. Cantilever type retaining wall profile (Project Implementation 2021)

a. Calculation of vertical force and moment about point A as Table 1 :

Table 1. Calculation of vertical forces and vertical moments

No	Weight W (kN)		Distance from A (m)	Moment (kNm)
1	0,3 x 3 x 24	21,60	0,75	16,20
2	½ x 0,1 x 3 x 24	3,60	0,57	2,05
3	2 x 0,5 x 24	24,00	1,00	24,00
4	1 x 0,5 x 24	12,00	1,75	21
5	1,1 x 3 x 18,8	62,04	1,45	89,96
		∑ W= 123,24		∑ M_v = 153,21

Source: Calculation Result 2021)

b. Calculation of active earth pressure and moment about point A as shown in Table 2 :

Table 2. Calculation of active soil pressure and horizontal moment

No	Soil Active Pressure P_a (kN)		Distance from A (m)	Moment (kNm)
1	3,5 x 10 x 0,34	11,9	1,75	20,82
2	½ x 18,8 x 3,5^2 x 0,34	10,37	1,17	12,13
		∑P_a= 2,27		∑ M_h =32,95

(Source: Calculation Result 2021)

c. Stability to overturning

FS overturning = $\frac{\sum M_V}{\sum M_h}$

= $\frac{153,21}{32,95}$

= 4,65 ≥2 (Safe)

d. Stability to sliding

FS sliding = $\frac{\sum W \; x \; tg\frac{2}{3}x\;29,24}{\sum P_a} = \frac{43,62}{22,27}$ = 1,96

= 1,96 ≥ 1,5 (safe)

e. Stability to the bearing capacity

In this case, Hansen's (1961) equation is used. It is considered that the foundation lies on the surface.

(1) Bearing capacity of retaining wall

a. Resultant value of vertical force

xe = $\frac{\sum M_v}{\sum M_h} = \frac{120,26}{123,24}$ = 0,97 m

b. Eccentricity value

e = $\frac{B}{2}$ – xe = 1-0,97 = 0,03 < $\frac{B}{6}$ = 0,33

c. Effective width

B'= B – 2e = 2 – (2 x 0,03) = 1,94 m

d. Effective area

A' = B' x 1 = 1,94 m^2

qmax = $\frac{\sum W}{B(1+\frac{6e}{B})} = \frac{123,24}{1,94\;(1+\frac{6.0,03}{1,94})}$

= 69,42 kN/m^2

qmin = $\frac{\sum W}{B(1+\frac{6e}{B})} = \frac{123,24}{1,94\;(1-\frac{6.0,03}{1,94})}$

= 57,81 kN/m^2

(2) Soil Bearing Capacity

In this calculation, the foundation of the retaining wall is considered to be located on the surface, so that Df =

0, dept factor $d_c=d_q=d_\gamma=1$, shape factor $s_c=s_q=s_\gamma=1$. For the ultimate bearing capacity calculation (q_u) Hansen's equation is used (1961) with load slope factor *(inclination)*, i.e :

$$i_q = \left\{\frac{1-(0{,}5H)}{(V+A'x\,C1\,x\,Ctg\,\theta)}\right\}^5$$

$$\left\{\frac{1-(0{,}5\,x\,22{,}7)}{(123{,}24+1{,}94x22{,}35\,x1{,}78)}\right\}^5 = 0{,}77$$

$$i_c = iq - \frac{1-iq}{Nc\,z\,tg\,\theta}$$

$$= 0{,}77 - \frac{1-0{,}77}{28{,}41\,x\,0{,}56} = 0{,}76$$

$$i_\gamma = \left\{\frac{1-(0{,}7H)}{(V+A'x\,C1\,x\,Ctg\,\theta)}\right\}^5$$

$$= \left\{\frac{1-(0{,}7\,x\,22{,}7)}{(123{,}24+1{,}94x22{,}35\,x1{,}78)}\right\}^5 = 0{,}66$$

$q_u = d_c \times i_c \times c \times Nc + d_q\, i_q \times D_f \times \gamma \times N_q + d_\gamma\, i_\gamma \times 0{,}5 \times B' \times \gamma \times N_\gamma$

$= i_c \times c \times Nc + i_\gamma \times 0{,}5 \times B' \times \gamma \times N_\gamma$

$= 0{,}76 \times 22{,}35 \times 28{,}41 + 0{,}66 \times 0{,}5 \times 1{,}94 \times 18{,}85 \times 13{,}49$

$= 645{,}36\ kN/m^2$

FS soil bearing capacity

$$\frac{q_u}{q_{max}} = \frac{645{,}36}{69{,}42} = 9{,}30 \geq 3 \text{ (aman)}$$

4.2. The Loading

Based on the results of the above calculation, that the stability of the cantilever type retaining wall national road sta 20+700 section 041 sta 20+700, section 041 or to be precise in Muaramais Village, Tambangan District, Mandailing Natal Regency, North Sumatra, obtained the value of the safety factor against bolsters ((overturning) of FS = 4,65. While the stability of the retaining wall against shear ((sliding) obtained FS of = 1.96 and the stability of the retaining wall against the bearing capacity of the soil obtained FS value of 9,30.

According to SNI 8460: 2017 that the stability of the cantilever type retaining wall on the national road sta 20+700, section 041 is safe against overturning, because the value (safety factor) against overturning ((overturning) the calculation results obtained are FS = 4,65 FS = 2,00 (SNI 8460: 2017) Then, the stability of the retaining wall against sliding (sliding) is safe, because the value (safety factor) against shear ((overturning) the calculation results are obtained at FS = 1,96 FS = 1,50 (SNI 8460: 2017. Furthermore, the stability of the retaining wall is safe against the carrying capacity of the soil, because the value (safety factor) on the bearing capacity of the soil calculated is FS = 9,30 FS = 3.00 (SNI 8460: 2017).

Hardiyatmo (2020) is of the opinion that the cantilever type retaining wall for national road sta 20+700, section 041 is safe against overturning, because the overturning moment of 32,95 kNm is capable of being countered by the moment due to the retaining wall's own weight and the resulting moment. the weight of the soil on the foundation slab is 153,21 kNm. Furthermore, against sliding, this retaining wall is also safe against sliding, because the forces that shift the retaining wall by 22,27 kN are still able to be resisted by friction between the soil and the foundation base of 123,24 kN. As for the bearing capacity, the retaining wall is still safe against the soil bearing capacity because the maximum bearing capacity of the retaining wall is 69,42 kN/m2, which is still capable of being supported by the soil at 645,36 kN/m2.

5. Closing

5.1. Conclusion

Based on the calculation results, that the handling of landslides with cantilever type retaining walls for national roads sta 20+700, section 041 is safe against overturning, because the calculated FS bolsters = 4,65 FS = 2,00. Then, retaining walls are safe against sliding, because FS shear = 1,96 FS = 1,50 and retaining walls are safe against soil bearing capacity because FS bearing capacity = 9,30 FS = 3,00.

5.2. Recommendation

Based on the calculation results, the cantilever type retaining wall of the national road sta 20+700 section 041 is safe against overturning, sliding and the carrying capacity of the soil. However, it is advisable to be able to carry out further research with a different location.

6. REFFERENCES

Das, BM. (1993). **Mekanika Tanah (Prinsip – prinsip Rekayasa Geoteknis).** The University of Texas at El Paso.

Donald D. (2019). **Analisis Perhitungan Kestabilan Dinding Penahan Tanah Studi Kasus Proyek Interchange Manado.** Jurnal Realtech Volume 15, Nomor 2 Oktober 2019 Program Studi Teknik Sipil, Fakultas Teknik Universitas Katolik De La Salle Manado.

Hardiyatmo HC. (2010). **Mekanika Tanah 2.** Edisi Kelima, Gadja Mada University Press

Hardiyatmo HC. (2012). **Tanah Longsor & Erosi** Gadja Mada University Press.

Hardiyatmo, HC. (2020). **Analisis dan Perancangan Fondasi I**, Gadja Mada University Press

Nakazawa K et al. (2000). **Mekanika Tanah & Teknik Pondasi.** PT. Pradnya Paramita, Jakarta

Redana IW. (2009). **Teknik Pondasi**. Udayana University Press

Wagola, ES and Rasyid, M. (2020). **Analisis Stabilitas Dinding Penahan Tanah Tipe Kantilever pada Landfill TPA Kota Masohi Kabupaten Maluku Tengah Provinsi Maluku**. *Rekayasa Sipil, Volume 14, No. 1 – 2020,* Program Studi Teknik Sipil, Fakultas Teknik, Universitas Iqra Buru, Kabupaten Buru, Provinsi Maluku.

Wesley, LD. (2012). **Mekanika Tanah Untuk Tanah dan Endapa***n*, Andy Yogyakarta.

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PRIORITY ANALYSIS OF RURAL INFRASTRUCTURE HANDLING IN JERUJU BESAR VILLAGE, SUNGAI KAKAP DISTRICT, KUBU RAYA REGENCY

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Abstract

The priority scale of village infrastructure development is important in order to provide greater value for the community. Data were collected through observation, and interviews. Data analysis includes prioritization, and infrastructure improvement strategies. This study resulted in priority areas for the agricultural and education sectors, namely hamlet of Karya Tani and hamlet of Karya Bersama with accessibility values of 9.03 and 8.67. hamlet of Karya Mulia has priority in the health, clean water, and electricity sectors with an accessibility value of 7.86; 8.09, and 6.40. Increased accessibility in the agricultural sector in the form of repairing irrigation, sluice gates, and procurement of water pumping machines, in the education and health sectors in the form of yard casting, in the clean water sector installing PDAM water networks or well water treatment, and the electricity sector by increasing the service life of electricity.

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1. Introduction

Infrastructure development in a system supports the activities that exist in a space. The availability of infrastructure can increase people's access to resources so as to increase efficiency and productivity leading to the economic development of an area (Gulo & Hariandja, 2017).

Rural in its service area is an area that has the main activity of agriculture, including natural resource management with the structure of the function of the area as a place for rural settlements, government services, social services, and economic activities. Rural means a residential area that is strongly influenced by soil, climate, and water conditions as an important requirement for the realization of the agrarian lifestyle of the population in that place (Sarini, et al., 2020).

Rural infrastructure is defined as infrastructure that is physical in nature and provides access to basic services as well as social and economic services for rural communities (Dirlanudin, et al., 2018).

The availability of village infrastructure in the form of basic infrastructure is very important in improving the living standards of rural communities by facilitating all social and economic activities of the population. Although it has been realized that it has an important position in efforts to achieve goals, however, strategic steps have not been seen by the parties involved in encouraging the improvement of the basic infrastructure planning process in Jeruju Besar Village, Sungai Kakap District, Kubu Raya Regency.

Accessibility is a measure of the convenience or ease of land use locations interacting with one another, and the ease or difficulty of these locations being reached through the transportation network system (Sarini, et al., 2020).

Rural access can be defined as the ability, level of difficulty of the villagers to use, achieve or obtain the goods and services needed (Azwansyah, et al., 2019). Regional accessibility is the ability or condition of an area to be accessed by outside parties either directly or indirectly. Good accessibility will facilitate community interaction between regions so that there is an even distribution of development. The potential in question is socio-economic potential such as income, family structure, and individual education level (Nurhadayani, et al., 2019).

Development of village infrastructure must be able to increase the dignity of life (human well-being) of village people. Activities to plan and build rural infrastructure based on community empowerment can increase employment and business opportunities for people in rural areas, and can increase community commitment to the sustainability of rural infrastructure they build. Procurement of rural infrastructure that involves the community is very appropriate because basically the technology used in rural infrastructure development is generally simple and still within the capacity of the village community.

The existence of a village fund allocation program allows the village to build a better and more advanced village. Jejuru Besar Village, a village that is part of the Sungai Kakap Sub-district, Kubu Raya Regency

located not far from the city center is now preparing to become a more developed and developed village. There must be an effort to organize and develop infrastructure to support activities and services to the community.

Based on the description above, a study was appointed, namely 'Study of Basic Infrastructure Accessibility Improvement in Jejuru Besar Village, Sungai Kakap District, Kubu Raya Regency. This research is expected to be a direction and guideline in managing and developing basic infrastructure in order to answer the real needs of the community in order to encourage the development of rural areas.

2. Methods

The process of this research refers to the framework illustrated in Figure 1.

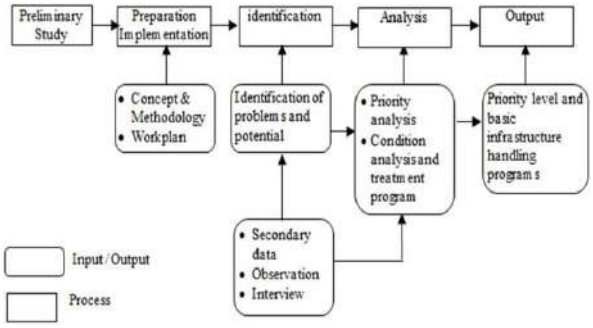

Fig.1. Research Framework The framework is explained as follows:

a. The initial stage is to conduct a preliminary study which is a review of previous studies supported by literature studies
b. The implementation preparation stage is the implementation preparation which includes the readiness of materials, concepts, methodologies, and preparing a work plan for the next stages.
c. The identification stage is to identify the potential and existing basic infrastructure problems. The basics for identification are input data, either in the form of primary data from field surveys, and direct interviews with the community, as well as secondary data which is carried out by taking supporting data from relevant agencies.
d. The analysis process stage, while the input at this stage is obtained through existing identification and information obtained through information gathering with government officials, the community, community leaders, and so on. Priority analysis and handling of infrastructure is carried out to determine the priority scale for infrastructure development plans and determine the handling of basic infrastructure and roads.

e. The output stage, which is produced is progress from the field which has given rise to concepts and plans for developing village road infrastructure related to regional development and other village infrastructure.

Data Collection Methods and Required Data include:

a. Field observation

Field observations are carried out to determine the potential conditions and problems that exist in the field, conduct a Cross Check on the identification of existing data, and to obtain the data needed to analyze a potential and problem. In this activity the data required include:

- Basic infrastructure physical condition.
- Basic infrastructure condition data.

b. Interview

Interviews were conducted to explore existing data and information as well as programs related to basic infrastructure components. These interviews were conducted with representatives from the community (youth, women, education, religious leaders), village officials, and others. In this study, a sample of 150 respondents was taken where the respondents consisted of 30 respondents from each hamlet (Jeruju Besar village consisted of 5 hamlets, namely Karya Bhakti Hamlet, Karya Utama Hamlet, Karya Tani Hamlet, Karya Mulya Hamlet, and Karya Bersama Hamlet.

A number of lists of questions are presented to respondents that are needed by the population in the IRAP Method, namely:

A. List of questions on the basic infrastructure of the social and economic sector

The contents of the questionnaire include: total population; total population; existence, facilities and infrastructure of service facilities; the number of households, farmers and fishermen; the quality and type of facilities used; distance, time and cost of travel; the number of agricultural and fishery products sold; transportation facilities and infrastructure, and public perceptions of problems and priorities.

B. List of Questions about village roads

The contents of the questionnaire include: agricultural potential, non-agricultural potential, the existence of health services used by the population, the number of elementary school students, the number of high school students, current access to the district, current access to markets, availability of clean water, state of affairs. roads before upgrading, road conditions as a problem for residents, and road conditions as a priority for residents.

The analysis carried out in this study includes:

a) Priority Scale

From Figure 2, after the database is ready, there are 4 (four) stages of activities that must be carried out to determine the priority level, namely:

i. Determination of indicator values

The scoring of each indicator is based on its accessibility conditions. The lowest value indicates that the indicator is in the best condition, while the highest value means that the indicator is in very poor condition. In the questionnaire grouped 5 levels. Namely (1)

very high, (2) high, (3) moderate, (4) low, and

(5) very low.

ii. Determination of indicator weight

The value of the weight of the indicator is based on the level of importance of the indicator. The more important the indicator, the greater the weight given. In the questionnaire, 5 choices were made, namely: (5) the weight is very important, (4) the weight is quite important, (3) the weight is quite important, (2) the weight is less important, and (1) the weight is not important

iii. Calculation of accessibility value (NA)

The formula used for calculating the accessibility value is:

NA = (Indicator Value x Indicator Weight) (1)

iv. Determination of Priority Level

Determination of the priority level based on the value of accessibility / road benefits, namely the highest value is the first priority, the next priority is the accessibility value below it and so on until the lowest value is the last priority

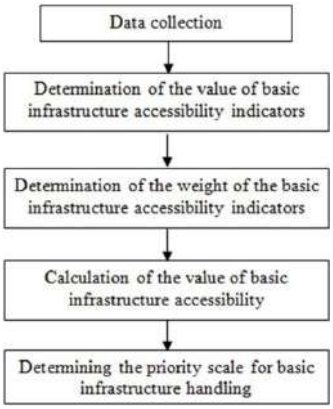

Fig.2.IRAP Method Analysis Proces

b) Infrastructure Improvement Analysis

Qualitative descriptive method is used to describe the basic infrastructure improvement plan based on field conditions. A survey of the condition of basic infrastructure is carried out by looking at the types of construction materials and the condition of the infrastructure.

3. Results and Discussion

Jeruju Besar Village has an area of 21.00 km2 or about 4.63% of the area of Sungai Kakap District. Jeruju Besar Village has a population in 2019 of 6,632 people with an area density of 315.8 people per km2 and the majority of Jeruju Besar Village residents work as farmers. Jeruju Besar Village is divided into 5 Hamlets namely Sangkar Mas, Sumber Makmur, Manunggal Karso, Maju Jaya, Margo Sari, and Suka Damai which are further divided into 10 Rukun Warga (RW) and 41 Rukun Tetangga (RT). The hamlets in Jeruju Besar Village include Karya Utama Hamlet, Karya Bersama, Karya Bhakti, Karya Mulya and Karya Tani (BPS Kubu Raya, 2020).

The majority of thisvillage relies on the agricultural sector, which isthe same as other villages in Sungai Kakap District. Apart from relying on the agricultural sector, Jeruju Besar Village also relies on the tourism sector such as the Equator Park Tourism which has been opened since December 2019 withmanagement by the Jeruju Besar Village-Owned Enterprise. However, it was officially launched by the Young Regent Mahendrawan on February 15, 2020.

3.1. Village Infrastructure Condition

The results of a direct survey to the field regarding the condition of the existing infrastructure in the village are as follows:

Access road to Jeruju Besar Village can be passed through 2 different routes from Pontianak City.The first route is through Pal Lima Village-Pal Sembilan Village-Sungai Kakap Village-Sungai Itik Village-Jeruju Besar Village, this route is a recommended route with good road conditions and can be taken for 40 minutes. While the second route is through TPI Pontianak-Rengas Kapuas Village-Jeruju Besar Village with slightly damaged road conditions with holes when entering Jeruju Besar Village and it takes 50 minutes to travel. Jeruju Besar Village is a center of activity for the surrounding villages, especially economic activities because there is a people's market with a service scope of three villages, namely Jeruju Besar Village, Sungai Kupah Village and Sungai Itik Village.

Most of the roads in Juruju Besar Village already use asphalt, but the condition of the asphalt roads has been damaged

Fig.3. Country road conditions

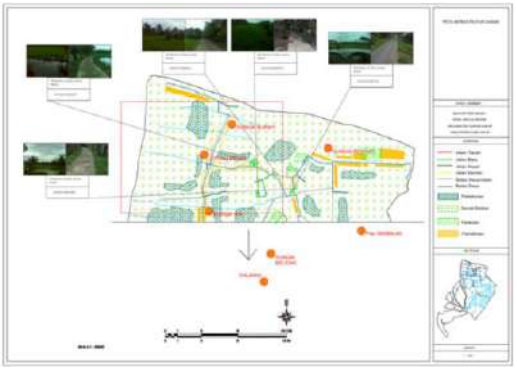

Fig.4. Distribution of Agricultural Land and Farming Road Conditions in Jeruju Besar Village

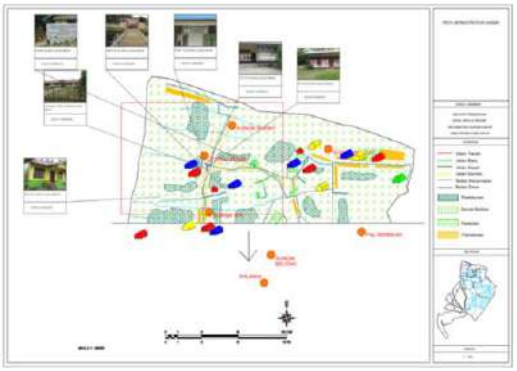

Fig.5. Distribution of Educational Infrastructure in Jeruju Besar Village

Fig.6. Distribution of Health Infrastructure in Jeruju Besar Village

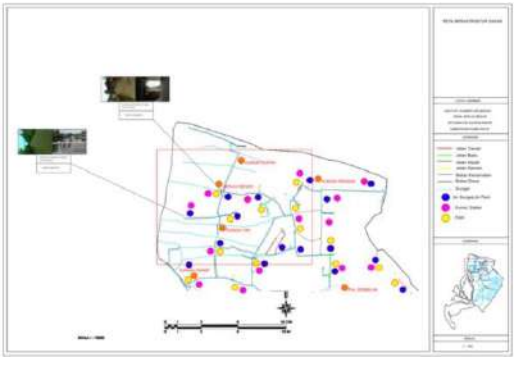

Fig.7. Distribution of Clean Water Source Facilities in Jeruju Besar Village

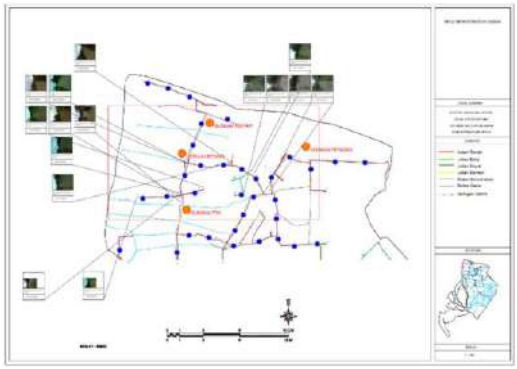

Fig.8. Distribution of the Electric Network in Jeruju Besar Village

The condition of the infrastructure for SMP, SD, PAUD, and playgroups is still very good with good and clean buildings. But it needs casting on the playground so that when it rains it doesn't get muddy and there are no facilities for playing.

The existing health infrastructure in Jeruju Besar Village is polindes, psoyandu, and postu. The condition of this infrastructure is still good and suitable for use, the surrounding yard needs to be arranged and tidy so that grass is not planted.

3.2. Population Characteristics

Characteristics of the villagers in terms of gender, it is known that the population of Jeruju Besar Village is predominantly female with a percentage of 51.15% while the male is 48.85%. Based on the religion embraced by the community, the population of Jeruju Besar Village is predominantly Muslim with a percentage of 95.22%, while the following is Buddhist at 4.15%. Based on the school age group, the dominant population of Jeruju Besar Village is aged 6-11 years with a percentage of 31.19% while the following below are aged 18-22 years at 24.81%. Based on the level of community education, the population of Jeruju Besar Village is dominant with no/not yet in school with a percentage of 36.65%, while the following are elementary school graduates at 33.13%. Based on the employment status of the community, the dominant population of Jeruju Besar Village has not worked with a percentage of 29,

3.3. Infrastructure Accessibility Analysis

The concept applied in this analysis is that accessibility is the level of difficulty. This means that the value of accessibility is directly proportional to the value of the indicator and the weight of the indicator, so the greater the value of the indicator and the weight of the indicator, the greater the value of accessibility and means that it is increasingly difficult for the population to meet their needs. So, it can be concluded that the greater the value of accessibility, the more prioritized to get an increase in accessibility. In this study, considering the large location, and scattered population settlements, the number of respondents taken was 150 respondents, where each hamlet amounted to 30 respondents.

The results of the accessibility analysis for each sector in Jeruju Besar Village at the hamlet level are as

follows: The initial step in calculating the accessibility value of an infrastructure is to compile the value of the accessibility indicator from the perceptions of the village community obtained from home interviews. The following table shows the perception of 30 respondents on the value of the accessibility indicator of the agricultural sector from indicator 1 (I1) to indicator 10 (I_{10}) in Karya Bhakti Hamlet.

Table 1.Respondents' Perceptions of the Value of the Accessibility Indicators of the Agricultural Sector in Karya Bhakti Hamlet

Respondent	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}
1	3	2	2	4	2	2	1	1	1	2
2	4	4	2	4	2	2	1	1	1	2
3	3	3	1	4	2	2	1	1	1	2
4	3	2	2	4	2	2	2	2	1	1
5	3	3	2	4	2	2	1	1	1	1
6	4	2	1	4	1	3	2	1	3	3
7	4	2	1	4	2	3	2	2	4	2
8	4	2	1	4	2	3	1	1	4	3
9	4	2	1	3	1	3	3	2	2	2
10	3	2	2	4	2	2	1	1	1	2
11	4	4	2	4	2	2	1	1	1	2
12	3	3	1	4	2	2	1	1	1	2
13	3	2	2	4	2	2	2	2	1	1
14	3	3	2	4	2	2	1	1	1	1
15	4	2	1	3	2	3	2	2	3	3
16	4	2	1	4	1	3	2	1	3	3
17	4	2	1	4	2	3	2	2	4	2
18	4	2	1	4	2	3	1	1	4	3
19	4	2	1	3	1	3	3	2	2	2
20	3	2	2	4	2	2	1	1	1	2
21	4	4	2	4	2	2	1	1	1	2
22	3	3	1	4	2	2	1	1	1	2
23	3	2	2	4	2	2	2	2	1	1
24	3	3	2	4	2	2	1	1	1	1
25	4	2	1	4	2	3	2	2	4	2
26	4	2	1	4	2	3	1	1	4	3
27	4	2	1	3	1	3	3	2	2	2
28	3	2	2	4	2	2	1	1	1	2
29	4	4	2	4	2	2	1	1	1	2
30	3	3	1	4	2	2	1	1	1	2

After compiling the perceptions of the respondents, the next stage is to compile the weights of the accessibility indicators from the perceptions of the village community which are also obtained from home interviews. The following table shows the perception of 30 respondents to the weight of the accessibility indicator of the agricultural sector from the weight of indicator 1 (B1) to the weight of indicator 10 (B10) in Dusun Karya Bhakti.

Respondent	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}
1	4	5	3	4	2	2	3	3	2	4
2	2	4	4	2	4	4	2	2	2	2
3	42	3	4	4	4	2	2	2	2	2
4	3	2	2	4	2	2	2	2	1	1
5	4	5	5	5	4	4	4	4	4	2
6	5	4	4	2	5	4	3	2	4	3
7	5	5	2	2	5	4	2	1	4	4
8	5	5	4	5	4	2	2	2	4	5
9	3	4	4	4	3	4	2	2	4	5
10	4	5	5	4	4	4	3	1	5	4
11	2	4	5	4	4	4	2	2	5	4
12	5	5	5	3	5	5	3	2	4	5
13	5	3	5	5	4	4	2	2	5	5
14	4	4	4	4	3	4	2	2	4	4
15	2	5	3	5	4	4	2	2	4	5
16	5	5	4	5	2	2	2	1	4	4
17	2	3	4	5	4	3	3	4	4	5
18	4	4	4	4	4	4	3	2	4	5
19	4	5	5	2	4	1	3	1	5	4
20	4	4	5	3	4	4	2	2	5	4
21	5	5	5	4	5	5	3	4	4	5
22	5	5	4	2	3	4	2	1	4	4
23	5	2	4	5	4	5	2	2	4	5
24	2	4	4	4	4	4	2	2	4	5
25	4	5	5	4	4	4	3	1	5	4
26	3	4	5	4	4	4	2	2	5	4
27	2	5	5	4	5	5	3	2	4	5
28	4	4	4	4	5	4	2	2	4	4
29	4	5	5	5	4	4	2	2	4	5
30	5	5	4	5	5	4	2	1	4	4

After the indicator values and indicator weights are arranged, the next step can be to calculate the accessibility value using the formula in equation 1.

As an example :

In Table 1 for respondent 1 and indicator 1 (I_1), the value = 3.

In Table 1 for respondent 1 and indicator 2 (I_2), the value = 2.

In Table 2 for respondent 1 and the weight of indicator 1 (B_1), the value = 4.

In Table 2 for respondent 1 and indicator weight 2 (B_2), the value = 5.

The component value is I1 x B1 = 3 x 4 = 12

I2 x B2 = 2 x 5 = 10

And so on so that the component values are obtained:

In respondent 1 : (I1 x B1 + I2 x B2 + ….+ I10 x B10)/i = (12 + 10 + 6 + 16 + 4 + 4 + 3 + 3 + 2 + 8)/10

= 6.80

In respondent 2: (I1 x B1 + I2 x B2 + ….+ I10 x B10) = (8 + 16 + 8 + 8 + 8 + 8 + 2 + 2 + 2 + 4)/10

= 6.60

And so on so that the value of the number of components Ii x Bi is obtained from respondent 1 to respondent 30. Furthermore, the total value Ii x Bi from 30 respondents is added up so that the total value is 2625. Accessibility value is obtained from the total value of Ii x Bi divided by the number of respondents, namely = 262.50 / 30 = 8.75

The complete calculation of the infrastructure accessibility value can be seen in the following table:

Table 3. Calculation of Infrastructure Accessibility Value Agricultural Sector in Karya Bhakti Hamlet

Respondent	I_1 x B_1	I_2 x B_2	I_3 x B_3	I_4 x B_4	I_5 x B_5	I_6 x B_6	I_7 x B_7	I_8 x B_8	I_9x B_9	I_{10}x B_{10}	(? (Ii x Bi))/i
1	12	10	6	16	4	4	3	3	2	8	6,8
2	8	16	8	8	8	8	2	2	2	4	6,6
3	126	9	4	16	8	4	2	2	2	4	17,7
4	9	4	4	16	4	4	4	4	1	1	5,1
5	12	15	10	20	8	8	4	4	4	2	8,7
6	20	8	4	8	5	12	6	2	12	9	8,6
7	20	10	2	8	10	12	4	2	16	8	9,2
8	20	10	4	20	8	6	2	2	16	15	10,3
9	12	8	4	12	3	12	6	4	8	10	7,9
10	12	10	10	16	8	8	3	1	5	8	8,1
11	8	16	10	16	8	8	2	2	5	8	8,3
12	15	15	5	12	10	10	3	2	4	10	8,6
13	15	6	10	20	8	8	4	4	5	5	8,5
14	12	12	8	16	6	8	2	2	4	4	7,4
15	8	10	3	15	8	12	4	4	12	15	9,1
16	20	10	4	20	2	6	4	1	12	12	9,1
17	8	6	4	20	8	9	6	8	16	10	9,5
18	16	8	4	16	8	12	3	2	16	15	10
19	16	10	5	6	4	3	9	2	10	8	7,3
20	12	8	10	12	8	8	2	2	5	8	7,5
21	20	20	10	16	10	10	3	4	4	10	10,7
22	15	15	4	8	6	8	2	1	4	8	7,1
23	15	4	8	20	8	10	4	4	4	5	8,2
24	6	12	8	16	8	8	2	2	4	5	7,1
25	16	10	5	16	8	12	6	2	20	8	10,3
26	12	8	5	16	8	12	2	2	20	12	9,7
27	8	10	5	12	5	15	9	4	8	10	8,6
28	12	8	8	16	10	8	2	2	4	8	7,8
29	16	20	10	20	8	8	2	2	4	10	10
30	15	15	4	20	10	8	2	1	4	8	8,7
										Total	262,5
										Accessibility Value	8,75

From the calculations in table 3, it is known that the accessibility value of the agricultural sector in Karya Bhakti Hamlet is 8.75.

Table 4. Calculation of Accessibility Value of Agricultural Sector Infrastructure in Karya Utama Hamlet

Respondent	$I_1 \times B_1$	$I_2 \times B_2$	$I_3 \times B_3$	$I_4 \times B_4$	$I_5 \times B_5$	$I_6 \times B_6$	$I_7 \times B_7$	$I_8 \times B_8$	$I_9 \times B_9$	$I_{10} \times B_{10}$	(? (Ii x Bi))/i
1	16	16	4	9	1	1	2	1	10	12	7,2
2	16	12	4	9	3	3	3	3	3	8	6,4
3	16	16	4	9	1	1	1	1	1	15	6,5
4	16	4	4	16	1	3	2	1	6	15	6,8
5	16	2	1	12	2	9	2	2	9	15	7
6	12	6	1	12	4	6	2	2	3	8	5,6
7	9	6	2	16	4	4	2	2	1	12	5,8
8	9	6	4	16	4	4	2	2	1	15	6,3
9	12	6	2	12	2	6	3	2	2	8	5,5
10	16	15	5	12	4	12	12	1	20	10	10,7
11	16	3	1	12	1	6	4	1	12	15	7,1
12	16	4	1	9	2	9	4	8	9	9	7,1
13	12	9	1	12	2	4	3	2	3	12	6
14	12	2	2	16	2	6	2	8	3	15	6,8
15	12	6	2	12	4	6	2	2	3	9	5,8
16	15	15	4	20	10	8	2	1	4	15	9,4
17	15	10	8	20	8	10	4	4	4	15	9,8
18	12	12	8	16	8	8	2	8	4	15	9,3
19	20	25	10	20	20	16	6	4	20	12	15,3
20	12	12	5	16	8	8	2	2	5	8	7,8
21	12	2	2	16	2	6	2	2	3	12	5,9
22	16	8	2	12	8	12	4	4	15	12	9,3
23	12	3	1	16	2	6	1	1	3	6	5,1
24	12	4	2	12	4	6	4	4	3	9	6
25	9	9	2	16	4	4	1	1	1	6	5,3
26	12	10	10	16	8	8	6	2	5	12	8,9
27	12	12	10	16	8	8	2	2	5	12	8,7
28	20	25	10	16	20	20	9	2	20	15	15,7
29	20	20	10	20	16	16	4	4	25	15	15
30	20	20	8	16	25	20	6	4	16	12	14,7
										Total	246,8
										Accessibility Value	8,23

In the same way, the accessibility value of the agricultural sector can be obtained in Karya Utama Hamlet (table 4), Karya Tani Hamlet (table 5), Karya Mulya Hamlet (table 6), and Karya Hamlet (table 7), as well as other village infrastructure.

Table 5. Calculation of Accessibility Value of Agricultural Sector Infrastructure in Karya Tani Hamlet

Respondent	$I_1 \times B_1$	$I_2 \times B_2$	$I_3 \times B_3$	$I_4 \times B_4$	$I_5 \times B_5$	$I_6 \times B_6$	$I_7 \times B_7$	$I_8 \times B_8$	$I_9 \times B_9$	$I_{10} \times B_{10}$	(? (Ii x Bi))/i
1	16	10	3	16	4	2	6	3	9	8	7,7
2	12	10	4	16	4	2	6	3	9	8	7,4
3	12	15	4	16	8	10	4	2	3	15	8,9
4	16	20	3	16	8	8	2	2	3	4	8,2
5	16	5	3	16	8	5	2	2	6	15	7,8
6	9	15	8	16	8	10	2	2	3	5	7,8
7	16	25	6	16	16	16	6	2	15	12	13
8	16	15	3	16	8	10	4	2	3	15	9,2
9	12	20	4	16	8	10	2	2	3	5	8,2
10	16	5	3	16	8	4	2	2	6	12	7,4
11	12	15	6	16	8	8	2	2	3	4	7,6
12	16	25	6	16	16	20	6	2	15	15	13,7
13	12	10	4	16	4	2	6	3	9	8	7,4
14	12	10	4	16	8	5	4	2	9	10	8
15	16	10	3	16	8	4	4	2	9	8	8
16	16	10	3	16	8	5	4	2	9	10	8,3
17	12	15	6	16	8	10	2	55	3	5	13,2
18	12	25	8	16	8	8	9	5	15	12	11,8
19	12	5	4	16	8	5	2	5	6	15	7,8
20	12	15	6	16	8	8	2	5	3	4	7,9
21	16	25	6	16	16	20	6	3	15	15	13,8
22	16	15	3	16	8	10	4	3	3	15	9,3
23	12	20	4	16	4	4	3	3	3	4	7,3
24	12	5	4	16	8	5	2	2	6	15	7,5
25	16	5	3	16	8	4	2	2	6	12	7,4
26	12	15	6	16	8	10	2	2	3	5	7,9
27	12	25	8	16	16	20	6	2	15	15	13,5
28	16	15	3	16	8	8	4	2	3	12	8,7
29	16	20	3	16	8	10	2	2	3	5	8,5
30	16	5	3	16	8	5	2	2	6	15	7,8
										Total	271
										Accessibility Value	9,03

Table 6.Calculation of Infrastructure Accessibility Value Agriculture Sector in Dusun Karya Mulya

Respondent	$I_1 \times B_1$	$I_2 \times B_2$	$I_3 \times B_3$	$I_4 \times B_4$	$I_5 \times B_5$	$I_6 \times B_6$	$I_7 \times B_7$	$I_8 \times B_8$	$I_9 \times B_9$	$I_{10} \times B_{10}$	(? (Ii x Bi))/i
1	15	9	4	12	4	4	4	3	3	4	6,2
2	12	15	5	12	6	3	4	4	4	3	6,8
3	8	12	5	6	6	6	3	3	3	5	5,7
4	12	8	5	6	6	3	4	3	3	5	5,5
5	16	12	5	2	10	3	4	4	4	5	6,5
6	9	10	4	16	8	5	4	2	9	4	7,1
7	12	4	3	8	4	4	4	2	9	6	5,6
8	12	9	6	9	6	10	2	2	3	5	6,4
9	12	20	4	6	12	12	6	3	15	6	9,6
10	12	4	3	8	6	3	6	3	9	6	6
11	12	6	4	16	8	5	4	2	9	4	7
12	9	6	4	12	8	10	2	2	3	3	5,9
13	12	15	6	6	12	12	12	3	15	15	10,8
14	12	4	5	8	6	3	4	3	9	4	5,8
15	8	6	4	16	8	5	6	2	9	6	7
16	9	12	10	6	6	6	4	3	3	5	6,4
17	8	20	4	6	12	12	6	3	15	15	10,1
18	12	4	3	8	6	3	6	3	9	4	5,8
19	16	6	5	8	10	3	8	4	12	6	7,8
20	15	12	10	4	6	6	4	3	3	5	6,8
21	16	10	4	6	20	12	6	4	20	15	11,3
22	9	15	6	16	8	10	9	6	9	6	9,4
23	15	20	10	4	12	15	8	6	9	9	10,8
24	12	20	4	6	12	12	4	6	9	15	10
25	12	10	6	8	12	15	6	6	9	15	9,9
26	9	9	8	16	8	10	2	2	3	2	6,9
27	12	15	6	8	8	8	2	2	3	3	6,7
28	16	10	6	12	16	20	6	2	15	15	11,8
29	9	15	10	8	6	6	12	9	9	6	9
30	9	20	10	8	12	15	8	6	9	9	10,6
										Total	235,2
										Accessibility Value	7,84

Table 7. Calculation of Infrastructure Accessibility Value Agriculture Sector in Dusun Karya Bersama

Respondent	$I_1 \times B_1$	$I_2 \times B_2$	$I_3 \times B_3$	$I_4 \times B_4$	$I_5 \times B_5$	$I_6 \times B_6$	$I_7 \times B_7$	$I_8 \times B_8$	$I_9 \times B_9$	$I_{10} \times B_{10}$	(? (Ii x Bi))/i
1	16	10	4	16	6	8	5	5	6	8	8,4
2	15	10	4	16	9	6	8	4	15	8	9,5
3	15	12	3	12	8	4	3	9	10	4	8
4	9	15	4	20	8	4	10	6	8	10	9,4
5	16	12	3	8	12	6	4	6	8	8	8,3
6	12	8	5	16	6	12	6	12	9	8	9,4
7	12	15	5	12	12	4	5	5	8	5	8,3
8	20	8	4	15	15	5	8	3	15	8	10,1
9	16	12	4	20	8	4	3	4	10	12	9,3
10	9	9	5	9	12	8	3	5	8	15	8,3
11	10	8	5	16	10	9	10	5	12	15	10
12	16	12	5	12	16	4	4	12	6	4	9,1
13	10	15	5	12	8	4	5	8	8	5	8
14	15	8	4	12	20	9	10	10	12	8	10,8
15	12	9	3	16	8	10	5	12	6	12	9,3
16	20	12	5	20	20	6	12	4	10	15	12,4
17	20	4	5	12	6	9	10	5	9	10	9
18	12	15	4	16	8	4	6	5	4	15	8,9
19	12	12	4	16	16	3	12	2	4	12	9,3
20	12	6	5	12	8	15	6	3	12	10	8,9
21	15	12	5	15	6	8	4	3	8	3	7,9
22	6	12	2	8	6	6	2	3	8	5	5,8
23	8	10	4	12	20	12	6	3	12	10	9,7
24	8	12	4	6	8	3	3	3	8	4	5,9
25	9	15	3	16	16	5	3	2	6	9	8,4
26	20	8	5	16	6	3	8	3	9	12	9
27	16	12	3	15	10	9	5	3	6	3	8,2
28	10	15	4	16	16	8	4	3	8	9	9,3
29	10	8	4	20	8	10	6	3	12	12	9,3
30	15	15	4	16	10	15	3	5	8	4	9,5
										Total	267,7
										Accessibility Value	8,92

Table 8.Recapitulation of Accessibility Value and Priority Scale of Agricultural Sector Infrastructure Handling Area

Hamlet	Accessibility Value	Priority
Karya Bhakti	8.75	3
Karya Utana	8.23	4
Karya Tani	9.03	1
Karya Mulya	7.84	5
Karya Bersama	8.92	2

Based on table 8, it is known that Karya Tani Hamlet has the greatest accessibility value compared to other hamlets, which is 9.03. This means that the handling

of agricultural sector infrastructure in Karya Tani Hamlet gets the first priority, then the second priority in Karya Bersama Hamlet with an accessibility value of 8.92, and the third priority in Karya Bhakti Hamlet with an accessibility value of 8.75.

Table 9.Recapitulation of Accessibility Value and Priority Scale for Education Sector Infrastructure Handling

Hamlet	Accessibility Value	Prioority
Karya Bhakti	4.86	4
Karya Utana	4.06	5
Karya Tani	5.96	3
Karya Mulya	7.26	2
Karya Bersama	8.67	1

the education, health, clean water and electrical energy sectors.

Based on the table above, it is known that Karya Bersama Hamlet has the greatest accessibility value compared to other hamlets, which is 8.67. This means that the handling of education sector infrastructure in Karya Bersama Hamlet gets the first priority, then the second priority in Karya Mulia Hamlet with an accessibility value of 7.26, and the third priority in Karya Tani Hamlet with an accessibility value of 5.96.

Table 10.Recapitulation of Accessibility Value and Priority Scale for Health Sector Infrastructure Handling

Hamlet	Accessibility Value	Prioority
Karya Bhakti	4.59	4
Karya Utana	4.22	5
Karya Tani	7.2	2
Karya Mulya	7.9	1
Karya Bersama	7.1	3

Based on the table above, it is known that Karya Mulia Hamlet has the greatest accessibility value compared to other hamlets, which is 7.86. This means that the handling of education sector infrastructure in Karya Mulia Hamlet gets the first priority, then the second priority in Karya Tani Hamlet with an accessibility value of 7.20, and the third priority in Karya Bersama Hamlet with an accessibility value of 7.06.

Table 11.Recapitulation of Accessibility Value and Priority Scale for Infrastructure Handling in the Clean Water Sector

Hamlet	Accessibility Value	Prioority
Karya Bhakti	5.48	5
Karya Utana	5.70	4
Karya Tani	6.98	3
Karya Mulya	8.09	1
Karya Bersama	7.15	2

Based on the table above, it is known that Karya Mulia Hamlet has the greatest accessibility value compared to other hamlets, which is 8.09. This means that the handling of the clean water sector infrastructure in Karya Mulia Hamlet gets the first priority, then the second priority in Karya Bersama Hamlet with an accessibility value of 7.15, and the third priority in Karya Tani Hamlet with an accessibility value of 6.98.

Table 12.Recapitulation of Accessibility Value and Priority Scale for Power Sector Infrastructure Handling

Hamlet	Accessibility Value	Prioority
Karya Bhakti	3.01	5
Karya Utana	4.75	2
Karya Tani	3.74	4
Karya Mulya	6.40	1
Karya Bersama	3.85	3

Based on the table above, it is known that Karya Mulia Hamlet has the greatest accessibility value compared to other hamlets, which is 6.40. This means that the handling of the electricity source sector infrastructure in Karya Mulia Hamlet gets the first priority, then the second priority in Karya Utama Hamlet with an accessibility value of 4.75, and the third priority in Karya Hamlet.

In general, improving the accessibility of village infrastructure is carried out with an intervention approach from the transportation and non-transportation aspects. On the transportation side, the interventions carried out include improving road quality, including road asphalting or road concreteization, and the provision of village transportation. While the intervention from the non-transportation side was carried out in the agricultural sector in the form of repairing irrigation and sluice gates, as well as the procurement of water pumping machines, the education and health sector in the form of yard casting, the clean water sector approach to the value of the intervention is to provide PDAM water sources or perform source processing. well water for daily needs as well as the provision of water reservoirs, from the electricity sector for household needs, it is sufficient but it is necessary to continue to improve services in the form of electricity that can live all day. In village government offices, electric power is still limited, so it needs to be increased by increasing electrical power

4. Conclusion

Based on the above analysis, this study can be concluded as follows:

a. Based on the level of community education, the population of Jeruju Besar Village is dominant with no/not yet in school with a percentage of 36.65%, while the following are elementary school graduates at 33.13%..

b. Based on the employment status of the community, the dominant population of Jeruju Besar Village has not worked with a percentage of 29.845% while the following below are other jobs at 24.88%.

c. The agricultural sector in Karya Tani Hamlet has the greatest accessibility value compared to other hamlets, which is 9.03, which means that the handling of agricultural sector infrastructure in Karya Tani Hamlet gets first priority.

d. The education sector of Karya Bersama Hamlet has the largest accessibility value compared to other hamlets, which is 8.67, which means that the handling of the education sector infrastructure in Karya Bersama Hamlet gets first priority.

e. Meanwhile, the health sector in Karya Mulia Hamlet has the largest accessibility value compared to other hamlets, which is 7.86, which means that the handling of the health sector infrastructure in Karya Mulia Hamlet gets the first priority.

f. The clean water source sector in Karya Mulia Hamlet has the largest accessibility value compared to other hamlets, which is 8.09, which means that the handling of the clean water sector infrastructure in Karya Mulia Hamlet gets first priority.

g. For the power source sector, it is known that Karya Mulia Hamlet has the greatest accessibility value compared to other hamlets, which is 6.40. This means that the handling of the electricity source sector infrastructure in Karya Mulia Hamlet gets first priority.

h. Interventions from the non-transportation side are carried out in the agricultural sector in the form of repairing irrigation and sluice gates, as well as the procurement of water pumping machines, the education and health sector in the form of yard casting, the clean water sector, the approach to the value of the intervention is to provide PDAM water sources or treat water sources. wells, while from the transportation side, road paving or road concreteization is carried out, and village transportation is provided.

5. Author's note

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6. References

Azwansyah, H., Syafaruddin AS, Sutarto YM. (2019). **Studi Prioritas Perbaikan Jalan Di Desa Durian Kecamatan Ambawang Kabupaten Kubu Raya**. Jurnal Teknik Sipil, Fakultas Teknik UNTAN, Edition Juni, Volume 19 Number 1, Pontianak, Indonesia.

BPS Kubu Raya. (2020) **Kecamatan Sungai Kakap Dalam Angka**.

Dirlanudin, Syafari, A; Nugroho, K. S., Indriyani, I., A (2018), **Model Pemberdayaan Masyarakat Melalui Dukungan Sarana Prasarana (Kasus di Desa Cikiruh Wetan dan Paniis Kabupaten Pandeglang**. Journal of Indonesian Public Administration and

Governance Studies (JIPAGS), Volume 2 Number 1, Page: 20 – 41. Gulo, I.T., Hariandja, B. (2017). **Metode Studi Kelayakan Dalam Perencanaan Infrastrutur, Jurnal Sistem Industri,** Volume 11 Number 2, Page: 151 - 166

Nurhidayani, A. F., Osly, P. J., Ihsan, I.. (2019). **Hubungan Aksesibilitas Terhadap Tingkat Perkembangan Wilayah Desa di Kecamatan Tambun Selatan Kabupaten Bekasi**, Jurnal Infrastruktur, Volume 4 Number 2, Page : 97 – 104.

Sarini, Irfan Ido, Sawaluddin. (2020). **Pemetaan Aksesibilitas Pusat Pelayanan Wilayah Perdesaan (Studi Kasus: Kecamatan Kabangka, Kabupaten Muna)**. Physical and Social Geography Research journal, Volume 2 Number 1, Universitas Halu Oleo, Kota Kendari, Indonesia

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ABILA PRECAST CONCRETE CONSTRUCTION METHOD FOR SIMPLE HOUSING

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Abstract

The purpose of this research is to arrange the stages of implementation of the ABILA precast concrete construction method to be applied to housing construction so that it can be used as a reference for future development. While the purpose of this research is to arrange the stages of housing construction with ABILA precast panels starting from the precast concrete production stage, transportation or mobilization of materials to the installation process and final completion. Precast concrete can speed up processing time, save costs, and minimize waste for formwork and scaffolding. In the world of construction, any waste of construction material must be reduced or even eliminated. The application of Precast Concrete is very easy, considering its plug and play nature. Besides being easy, precast concrete has quite a lot of applications, especially the Abila Panel which has a function as a building structure, it can also be used as fences, floors and drainage channels. The level of the implementation method for the development of precast concrete technology is divided into several levels between prefabrication, preassembly, and module. The implementation method of building a house with ABILA precast concrete takes 14 days in the field, starting from panel installation to finishing. The construction method includes prefabrication in the workshop, mobilization of panels to the job site, assembly of structural elements, installation of brick walls, installation of roof structures and roof coverings, electrical and mechanical floor work, installation of ventilation doors and windows and paint finishing.

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ABILA, precast concrete, construction

1. Introduction

Precast concrete is starting to be widely used by housing developers in the process of building simple residential houses for the lower middle class. The precast concrete is used as a structural component in the form of sloof, beams and columns before being assembled into buildings. In 2017, during a working visit to Padang, West Sumatra, the Minister of PUPR Basuki Hadimuljono supported the development of the national precast concrete industry when he visited PT. Kunangi Jantan, a local company from West Sumatra that produces precast concrete building components, steel structures, iron poles, cinder blocks and concrete blocks as well as galvanized pipes.

In its application in the housing sector, the Ministry of PUPR has developed a precast technology called RISHA (Simple Healthy Instant House) which is a knock down construction technology that can be built quickly using reinforced concrete in the main structure. Adopting RISHA technology, PT. Jusuf Salam is a housing developer domiciled in Singkawang City that develops precast concrete which can be used for structural elements of single or multiple residential buildings..

According to Ervianto (2006), it is possible for the precast system method to be applied to various types of construction project implementation, such as the construction of high-rise buildings, bridges, industrial buildings, housing, ports and so on. The use of precast concrete is expected to be able to answer the challenges of industrialization which demands effective, efficient, quality and economical work results (Khakim 2011).

The purpose of this research is to compile the stages of implementing the ABILA precast concrete construction method which is relatively new to be applied to the residential construction so that it can be used as a reference for widespread development. While the purpose of this research is to arrange the stages of residential house construction with ABILA precast panels starting from the precast concrete production stage, transportation or mobilization of materials to the installation process and final completion.

2. Materials and Method

Almost all aspects of construction work use concrete, including the construction of residential houses. Tri

Mulyono (2004) suggests that all structures in civil engineering will use concrete, at least in foundation work. Precast concrete is an example of innovation that is now widely used in construction processes such as buildings and bridges, this is because precast concrete can speed up the processing time, save costs, and minimize waste for formwork and scaffolding. In the world of construction, the remaining construction material (waste) must be reduced or even eliminated (Adiasa, et al. 2015)

This research was conducted by direct observation of the construction process of the Abila Housing in Singkawang City, starting from the process of preparing the panel material printing to the process of implementing the construction on the provided house footprint. According to Tommy et al (2015), Precast systems are divided into 2 categories, namely as a structural component where precast system technology is not only used for buildings, but can also be used in other building structures such as piles, sheet piles and diaphragm walls, bridge girders and flyovers, sheet piles, slabs. precast floors, precast concrete blocks, wall panels, precast stairs and more. Then the second system is a structural system where precast system technology is developing quite rapidly and innovating into various structural systems categorized into 36 precast systems by the IAPPI (Indonesian Association of Precast and Prestressing Experts).

2.1. Abila Panel Components

Abila panel, is a precast concrete that has iron as the main reinforcement and cast concrete with a composition of sand, cement and gravel. See Figure 1.

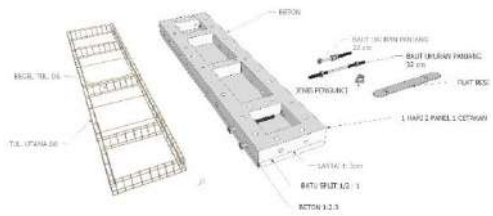

Figure 1. Abila Panel Components

There is also the size of the Abila Panel that can be adjusted to the needs of its use, namely; 1.2 m, 1.5, 2.3 m and 3 m. This allows the panels to be mobilized and assembled easily. See Figure 2.

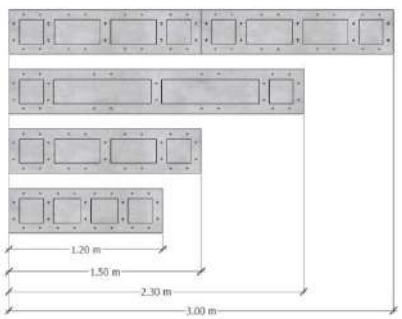

Figure 2. Abila Panel Size

2.2. The Application of Abila Panel

The application of Precast Concrete is very easy, considering its plug and play nature. Besides being easy, precast concrete has quite a lot of applications, especially the Abila Panel which has a function as a building structure, it can also be used as fences, floors and drainage channels. See Figure 3 and Figure 4.

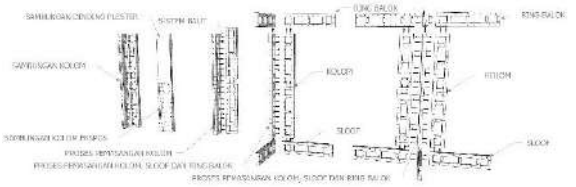

Figure 3. Abila Panels as Structures

Figure 4. Abila Panel as the floors and drainage system

In buildings, Abila panels function as structural elements that can be combined with wall coverings, such as; brick, red brick, press brick, hebel, interlock brick, composite panel and so on. See Figure 5.

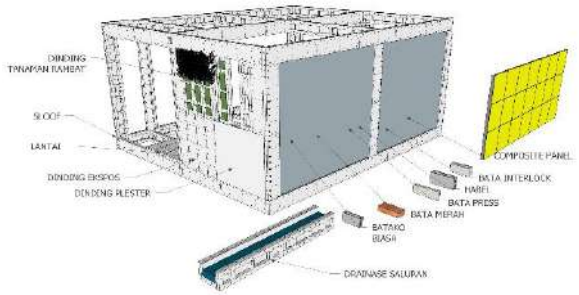

Figure 5. Combination of Abila Panel and walls

3. Discussion and Result

3.1 Simple House Construction Implementation Methods with Abila Panels

The level of the implementation method for the development of precast concrete technology is divided into several levels between prefabrication, namely the manufacturing process carried out using special tools where various types of materials are combined to form part of a building. Then preassembly, which is the process of unifying the fabricated components in a place that is not in the position where the component is located. Next is the module, which is the result of the unification process of manufacturing components, usually requiring a large enough transportation mode to move it to its proper position (Ervianto & Suryantoro, 2006).

3.1.1 Abila Abila Panel Production Stage

The Abila Panel production process begins with printing panels using iron plate modules of varying sizes. In the production process, the main reinforcement is assembled with 8mm diameter iron arranged in parallel following the cavity in the iron plate module, then filling the module with cast concrete. The time required for the production of 1 Abila Panel is 10 hours. See Figure 6.

Figure 6. Abila Panel Production

In simple terms, concrete is formed by hardening a mixture of cement, water, fine aggregate (sand), and coarse aggregate (crushed stone or gravel). Sometimes, a mixture of other ingredients (admixture) is added to improve the quality of the concrete. Several principles are believed to provide more benefits from this precast concrete technology, including those related to time, cost, quality, predictability, reliability, productivity, health, safety, environment, coordination, innovation, reuseability, and relocability. (M. Abduh 2007).

3.1.2 Construction Stage on Building

Construction Phase of Abila Panels are mobilized to the construction site or Abila Panels can be produced directly at the construction site. The foundation footprint is prepared as a panel holder, then the panels are arranged as sloof, columns and beams with connections using 22 cm and 32 cm bolts with locks, see Figure 7. The panel requirements for 1 (one) type 36 housing unit are approximately 48 panels of type size 1.5 meters. The workforce required for sloof, column and reverse structure work is 6 people for 1.5 working days.

Figure 7. Building Structure

The next construction process is building wall work using bricks/brick, floor casting work and building roof work. See Figure 8.

Figure 8. Wall and Roof Works

3.1.3 Finishes the Building

The finishing stage is the final stage in the construction of a simple house such as closing, coating and beautifying the building. See Figure 9.

Figure 9. Work Finishing

3.2 Construction Execution Time

The duration of the structural work using the conventional method is 30 days or 5 weeks and for the analysis of the duration of the structural work with RISHA precast technology is 5 days or 1 week (Salim, 2022). In general, the construction time using ABILA precast concrete as a structural element is estimated to be faster than the conventional method. The duration of work for each work item in the field can be seen in Table 1 below.

Table 1. Construction Period

Job Description	Time (Days)
Printing 48 Abila Panel	5
Site foundation	5
Panel Mobilization	1
Structural Construction (Sloof, Beam and Column)	2
Bricking and plastering the walls	5
Light Steel Roofing and Roof Covering	3
Floor Casting	2
GRC, PVJ and Electrical Ceiling	4
Sanitary (Tools and Pipelines)	5
Ceramic Floor Finishing	4
Paint Finishing	5

3.2.1 Production Work 48 Panels Abila

For one housing unit type 36 requires 48 concrete panels measuring 1.5 meters. The number of needs includes sloof, column and beam components. The process of ironing and casting in iron moulding takes 5 days before the panels are mobilized to the work site. The total number of workers involved in the ironing process is 2 people, 2 people are found in the casting process and 1 person is in charge of opening the panel molds..

3.2.2 Tread Foundation Work

The parallel process of tread foundation work coincides with the panel production process so that when the precast concrete panels are ready to be mobilized, the condition of the structure is ready for use and direct assembly of structural components in the field is carried out. The process of excavating the tread foundation, ironing for formwork and casting takes 5 days with a total of 5 workers.

3.2.3 Panel Mobilization

The parallel process of tread foundation work coincides with the panel production process so that when the precast concrete panels are ready to be mobilized, the structural conditions are ready for use and direct assembly of structural components in the field is carried out.

Figure 10. Panel Arrangement for Mobilization

3.2.4 Wall and Plastering the Wall

Wall work using adobe walls and in conjunction with backfilling sand for the floor. Wall work and plastering of the outer walls of the building are carried out by 4 workers with a period of 5 working days.

3.2.5 Roofing and Flooring Works

The roof structure material uses mild steel and zincalum roof covering material. The work is carried out by 4 workers with 3 working days. Simultaneously with the roof work, floor casting work was also carried out which involved 3 workers (mixture of cement and casting).

3.2.6 GRC, PVJ and Electrical Ceiling Works

The GRC ceiling work is carried out for 4 working days with a total of 3 workers. During the execution of the ceiling work, door, window and ventilation installations were also carried out as well as the installation of electrical networks throughout the building.

3.2.7 Sanitary Work

Sanitary work includes the installation of sanitary equipment such as faucets and toilets. This work also prepares clean water and dirty water pipelines as well as clean water wells and septic tank excavations. 2 people involved in the installation of sanitary equipment and pipelines and 2 people digging wells and septic tanks.

3.2.8 Ceramic Floor Finishing Works

Ceramic floor finishing work measuring 40 x 40 cm for the room and 25 x 25 for the bathroom. This work involves 4 workers where 1 person prepares the cement mortar, 1 person installs the ceramics for the main room, 1 person installs the ceramic tile for the room and 1 person installs the ceramic.

3.2.9 Paint Finishing Job

The exterior and interior paint finishing work involved 6 workers for 5 days of implementation. When the building paint finishing work is carried out cleaning the building area so that the building can be occupied immediately.

4. Conclusion

The implementation method of building a house with ABILA precast concrete takes 14 days in the field, starting from panel installation to finishing. The construction method includes prefabrication in the workshop, mobilization of panels to the job site, assembly of structural elements, installation of brick walls, installation of roof structures and roof coverings, electrical and mechanical floor work, installation of ventilation doors and windows and paint finishing.

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6. References

Abduh, M, (2007). **Inovasi Teknologi dan Sistem Beton Pracetak di Indonesia : Sebuah Analisa Rantai Nilai.** Seminar dan Pameran HAKI 2007.

Adiasa, Aziz Mudzakir; Prakoso, D.,K.; Hatmoko, J., U., D. (2015). **Evaluasi Penggunaan *Precast* di Proyek Konstruksi**. Jurnal Karya Teknik Sipil Volume 4, Nomor 1 Hal. 126 – 134. Universitas Diponegoro, Semarang.

Ervianto, Wulfram I.; Suryantoro, S. (2006). **Eksplorasi Teknologi Dalam Proyek konstruksi beton Pracetak & Bekesting.** Penerbit Andi Offset, Yogyakarta.

Khakim, Zainul. (2011). **Studi Pemilihan Pengerjaan Beton Antara Pracetak dan Konvensional pada Pelaksanaan Konstruksi Gedung dengan Metode AHP**. Jurnal Rekayasa Sipil Volume 5, Nomor 2-2011. Universitas Brawijaya, Malang.

Mulyono, Tri. (2004). **Teknologi Beton**. Penerbit Andi Offset, Yogyakarta.

Salim, M Afif; Siswanto, A.B.; Hartono; Rozaq, B. (2022). **Analisis Perbandingan Waktu dan Biaya Penggunaan Teknologi RISHA dan Metode Konvensional Pada Proyek Perumahan**. Jurnal Rekayasa Infrastruktur Hexagon 6 (2), 48-57.

Tampubolon, Tommy William.(2015). **Analisa Indeks Kinerja Pekerjaan Produksi Beton Pracetak Sistem DPI (Studi Kasus Proyek Aeropolis Crystal Residence)**. Universitas Bina Nusantara, Jakarta.