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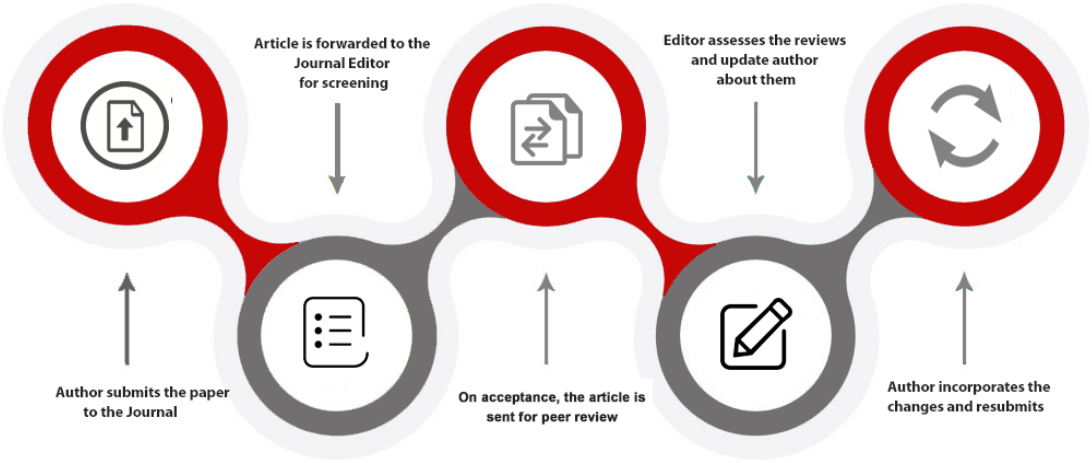

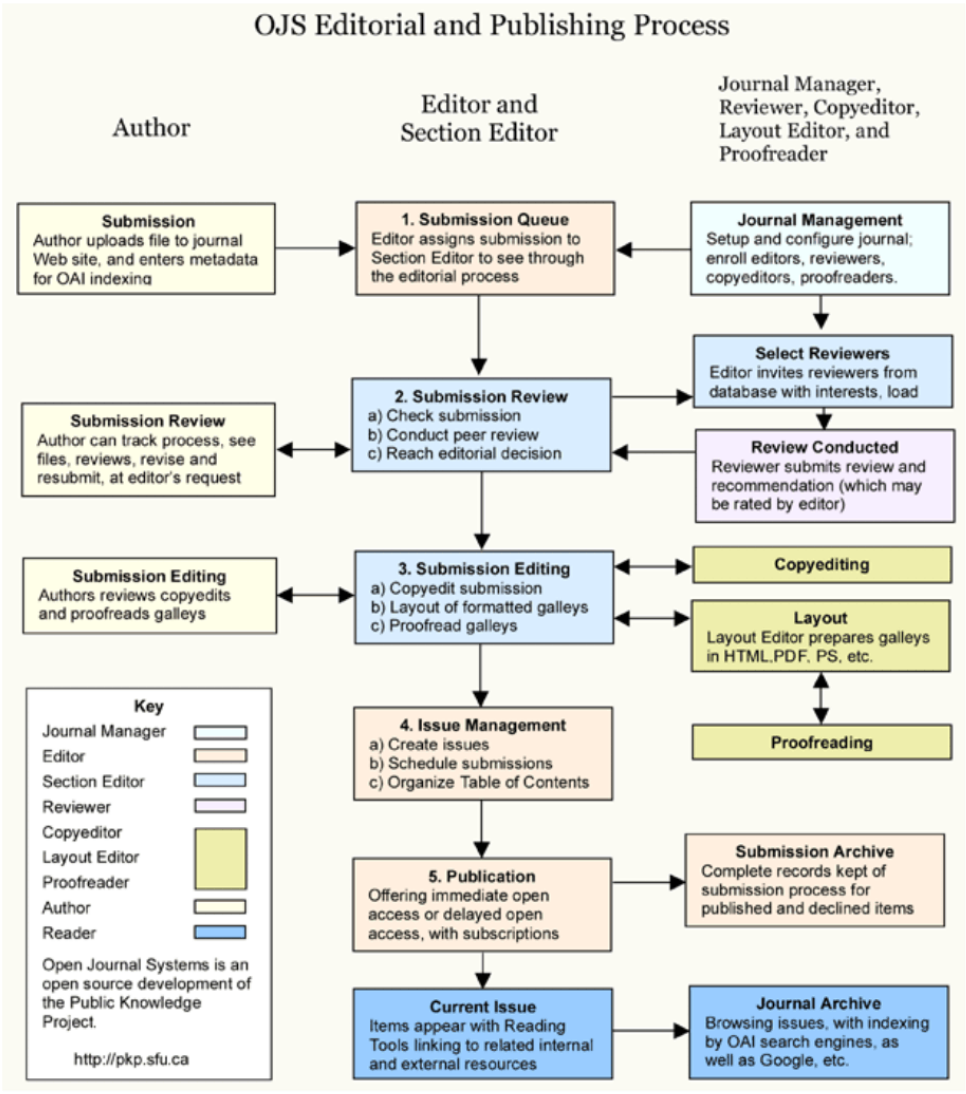

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The Effect of The Use of Limestone As a Cement Subtitution and Ceramic Waste or Tile As a Coarse Aggregate Subtitution in Concrete Mixtures to The Strength of Concrete Press

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Abstract

Concrete is the result of the preparation of materials consisting of cement, aggregate and water. All the constituent materials of concrete are obtained from natural resources, which, if exploited continuously will be increasingly depleted. The use of waste as an added material or as a substitute material is a good alternative for mixing the building blocks of concrete. Extinguished lime is one of the materials for making cement where quenched lime is made without a fabrication process such as cement which produces waste during the fabrication period. As for ceramic or tile waste, it is one of the building wastes that cannot be used anymore so that ceramic waste can be used as a substitute for coarse aggregate in the concrete mixture. This study aims to determine the effect of using extinguished lime as a substitute for cement and ceramic or tile waste as a substitute for coarse aggregate in the concrete mixture on the compressive strength of concrete. This study used a cylindrical specimen measuring 15x30 cm as many as 40 samples from 4 mixed variations and added with 4 normal concrete samples which serve as benchmarks. This study used a mixture of lime substitute as much as 15%, and 25% by weight of cement, as well as ceramic or tile waste as much as 30%, and 60% of the weight of coarse aggregate. Where the concrete compressive strength test was carried out on day 28. The results of this study were that the resulting slump value was still in accordance with the mix design with a range between 60-180 mm with the highest slump value found in the variation of 15% lime + 60% ceramic waste, namely 15 cm.

Keywords:
Ceramic Waste, Concrete Compressive Strength, Limestone, Substitution, Tile Waste.

1. Introduction

1.1. Background

Technological developments in the building construction continue to experience developments not only in Indonesia but also in various parts of the world. The majority of buildings are designed using concrete with high quality including strength, durability (durability), and efficiency. Concrete is a construction material composed of water, sand, gravel, and cement mixed into one unit. Of the many existing constructions, concrete is a component that is almost always used as an architectural combination, foundations, beams, slabs, dams, and drainage channels, so the demands for the use of concrete are getting higher.

Reducing air pollution and environmental damage caused by cement factory waste by reducing the amount of cement used, by reducing the use of cement is expected to reduce cement production so as to reduce air pollution and environmental damage due to cement factory waste.

Damage to the ecosystem in the river and the environment around the river due to illegal rock mining will have an impact in the future, one of which is the increase in river flow which results in landslides around the river, and damages the ecosystem in the river, so this illegal mining needs to be stopped.

So that an alternative is needed to at least reduce the use of cement by using other materials such as lime, so that the use of cement can be reduced in number, Likewise the use of coarse aggregate which must also be reduced by replacing it with other materials, The use of ceramic or tile waste as a mixture of concrete is one of the alternatives to reduce the use of cement and coarse aggregate which is usually used in making concrete mixtures.

1.2. Formulation of the problem

1. How is the effect of quenched lime as a substitute for cement and ceramic waste substituted in coarse aggregate in the concrete mixture on the slump value?
2. How is the effect of quenched lime as a substitute for cement and ceramic waste which is substituted in coarse aggregate in the concrete mixture on the value of the compressive strength of concrete?

2. Literature Review

Concrete complies (Nawy, Edward G., Suryoatmono, Bambang 2001) Indicates that simple concrete is formed by hardening a mixture of cement, water, fine aggregate, coarse aggregate (crushed stone or gravel), air and sometimes other additional mixtures.

2.1. Materials - Concrete Composer Materials

Nearly 60% of the meterial used in construction work is concrete, which is generally combined with steel (composite), or other types (Mulyono 2019). According to Mulyono (2019) Concrete is a function of its constituent materials consisting of hydraulic cement (Portland cement), coarse aggregate, fine aggregate, water and additives (admixture or additive).

2.2. Limestone

Limestone (limestone) is a type of carbonate rock that occurs in nature, also called limestone. The main mineral of limestone is calcite (CaCO3), other minerals are impurity minerals, usually consisting of quartz (SiO2), carbonates associated with iron and clay minerals, and organic plant residue (Aziz 2010). Limestone resources owned by Indonesia are very large (Anonymous. 2003), which is ± 2.156 billion tons, which are scattered in several regions in Indonesia, namely: N. Aceh Darussalam (131.12 billion tons (Mt)), North Sumatra (3, 24 Mt), West Sumatra (68.1 Mt), Riau (53.2 million tonnes (M)), Bengkulu (137.1 Mt), Jambi (157 M), South Sumatra (294 M), Lampung (2 M), Banten (61.6 M), West Java (660.3 M), Central Java (6 Mt), DI Yogyakarta (10 Mt), East Java (3,069 Mt), Bali (154.64 Mt), NTB (1.2 Mt), NTT (132.82 Mt), Central Kalimantan (449 Mt), South Kalimantan (8.33), East Kalimantan (57 Mt), North Sulawesi (18.8Mt), Gorontalo (18.5Mt), Central Sulawesi (696 Mt), South Sulawesi (31.33 Mt), Southeast Sulawesi (1,527 Mt), North Maluku (8.87 Mt), and Papua (2.6 Mt). Quicklime and extinguished lime are conventional products of the limestone industry, limestone is burned in a calcination furnace with a combustion temperature of 900 - 1000 ° C where limestone (CaCO3) breaks down, into quicklime (CaO) and CO2 gas, extinguished lime is made by reacting CaO is the result of calcination with water (H_2O) to form calcium hydroxide (Ca (OH) senyawa), this process is also called quicklime hydration (Kibria et al. 2016). Central Sulawesi (696 M), South Sulawesi (31.33 Mt), Southeast Sulawesi (1,527 Mt), North Maluku (8.87 Mt), and Papua (2.6 Mt). Quicklime and extinguished lime are conventional products of the limestone industry, limestone is burned in a calcination furnace with a combustion temperature of 900 - 1000 ° C where limestone (CaCO3) breaks down, into quicklime (CaO) and CO2 gas, extinguished lime is made by reacting CaO is the result of calcination with water (H_2O) to form calcium hydroxide (Ca (OH) senyawa), this process is also called quicklime hydration (Kibria et al. 2016). Central Sulawesi (696 M), South Sulawesi (31.33 Mt), Southeast Sulawesi (1,527 Mt), North Maluku (8.87 Mt), and Papua (2.6 Mt). Quicklime and extinguished lime are conventional products of the limestone industry, limestone is burned in a calcination furnace with a combustion temperature of 900 - 1000 ° C where limestone (CaCO3) breaks down, into quicklime (CaO) and CO2 gas, extinguished lime is made by reacting CaO is the result of calcination with water (H_2O) to form calcium hydroxide (Ca (OH) $_2$), this process is also called quicklime hydration (Kibria et al. 2016).

2.3. Ceramic or Tile Waste

Ceramics are a building element that is used to cover floors or walls which are usually in the form of thin and square plates, which are made of clay and other ceramic raw materials, by burning them to a certain temperature so that they have special physical properties (Suria, A., Neneng, I., & Alamsyah 2017).

3. Research Methods

The research methodology is used to obtain data for research purposes carried out in a systematic and structured manner. In this research, the method used is an experimental method by mixing (substitution) cement with lime and substituting coarse aggregate with ceramic or tile waste in the concrete mixture.

3.1. Research Percentage

In this study, the use of chalk and ceramic waste was varied, as for the presentation itself, 15% and 25% of the weight of cement were used for quenched lime, according to the study (LUAN DALAM Rerc YASA, SMA SATA WERDHAPU RA SnruuR -Elaur, and Jun 2010). The use of ceramic or tile waste used is 30% and

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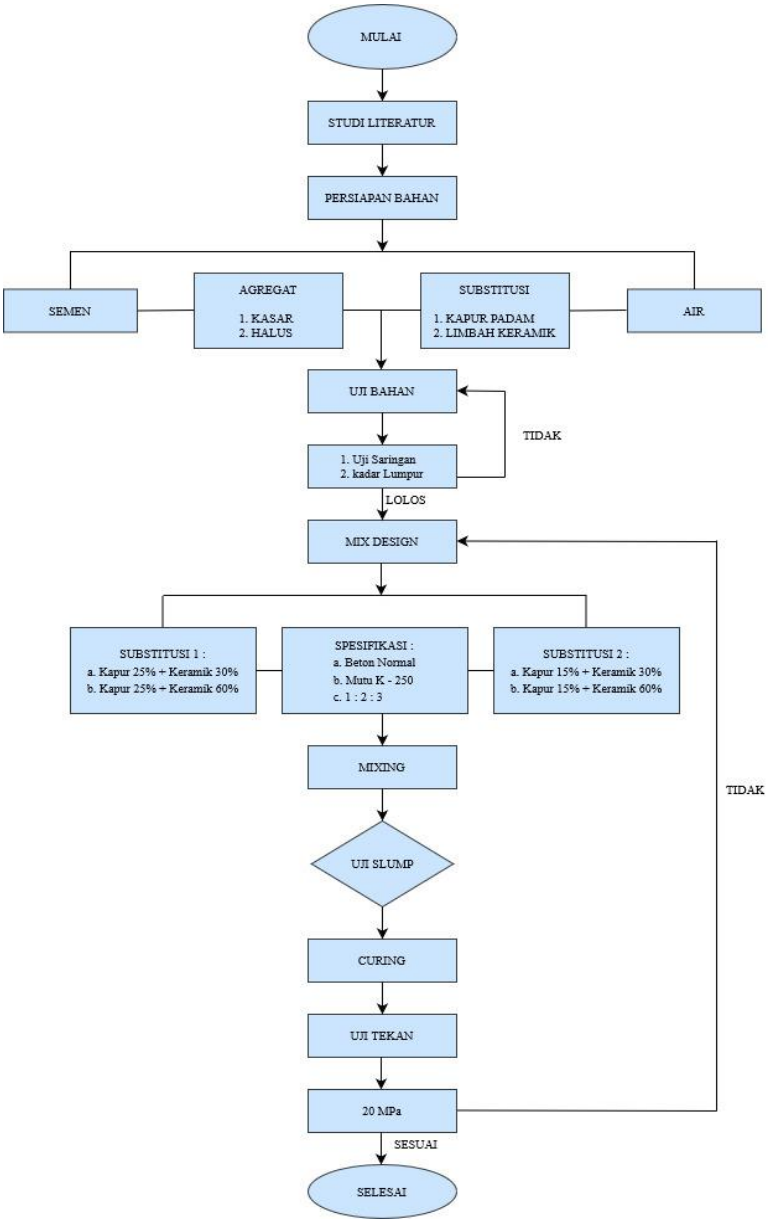
60% of the weight of coarse aggregate (gravel) referring to research (Kurniawan Dwi Wicaksono 2012). The two variations will be combined between extinguished lime and ceramic or tile waste, for concrete compressive strength testing will be carried out at the age of 28 days referring to research (LUAN DALAM Rerc YASA et al. 2010).

Table 3.1 Substitution Percentage

Percentage	
Limestone	Ceramic waste
15%	30%
	60%
25%	30%
	60%

Source: Personal Data

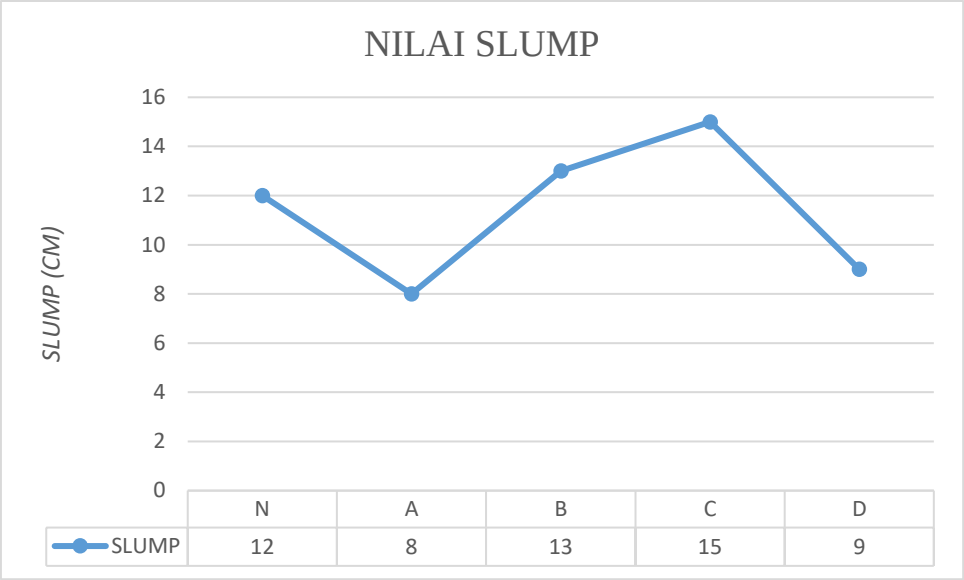
3.2. Research Flowchart



Source: Personal Data
Figure 1. Flowchart

4. Research Results and Analysis

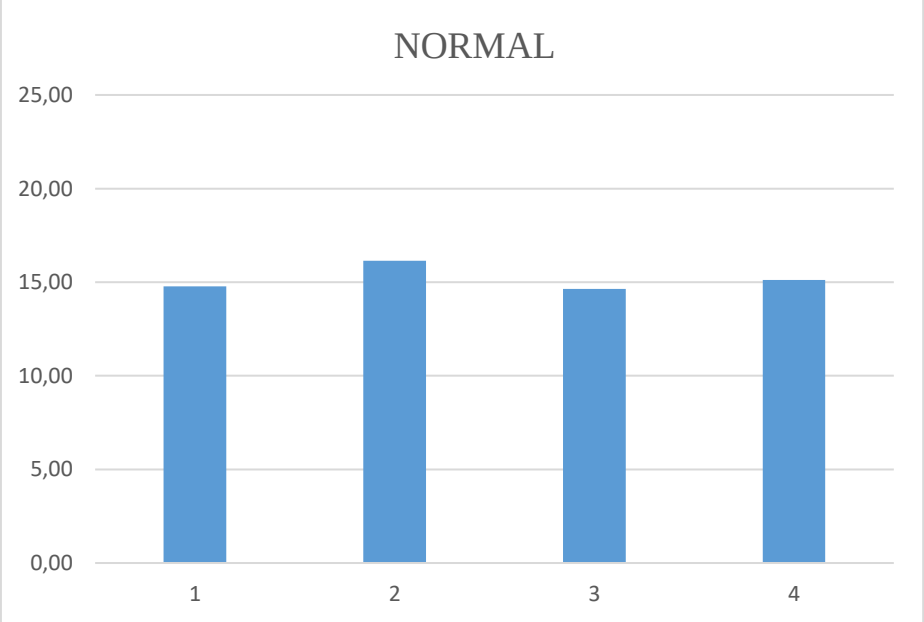
4.1. Slump Value Testing Results



Source: Personal Data

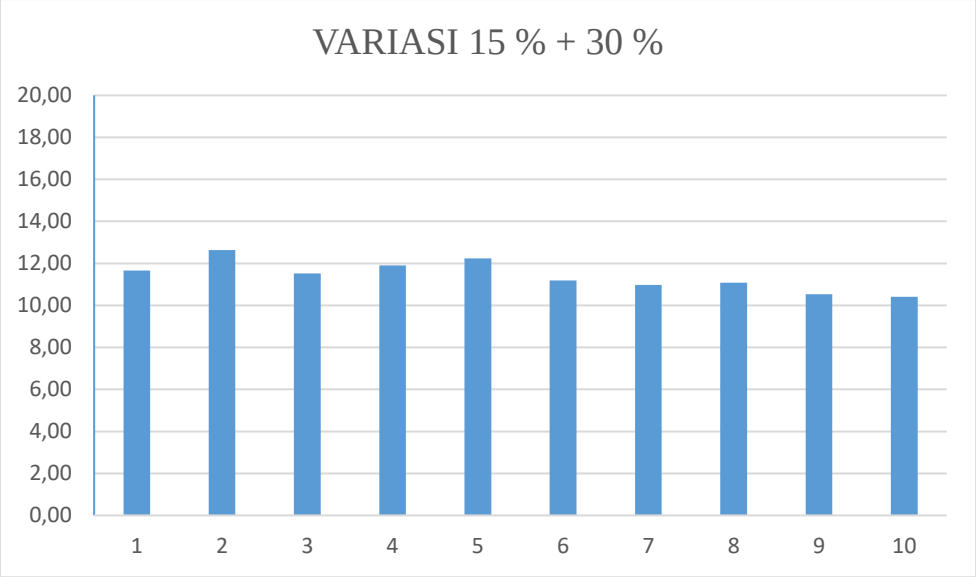
Figure 2. Graph of Slump Value Testing Results

4.2. Concrete Compressive Strength Test Results

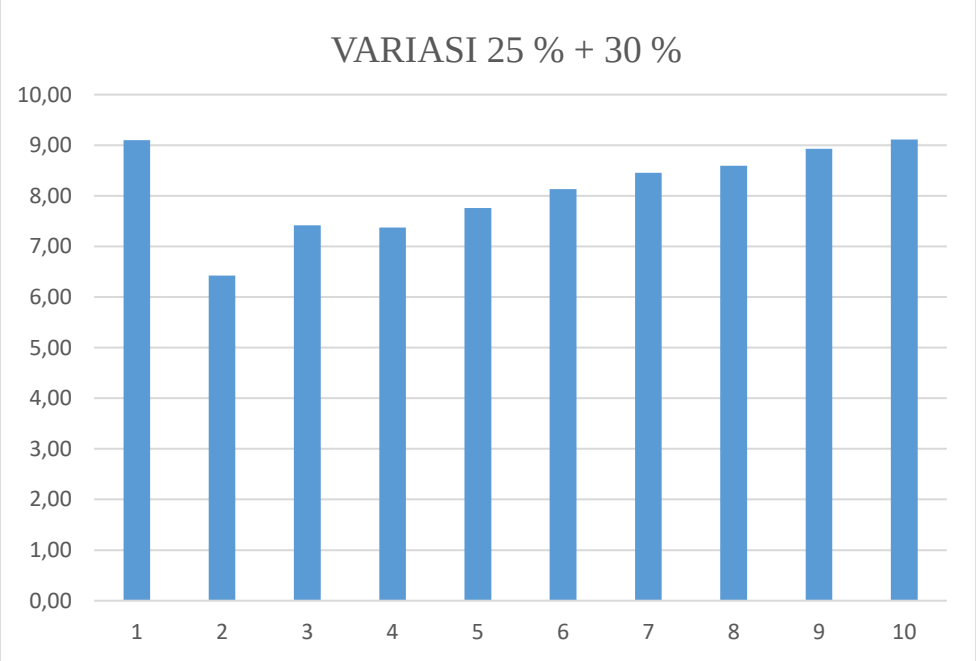


Source: Personal Data

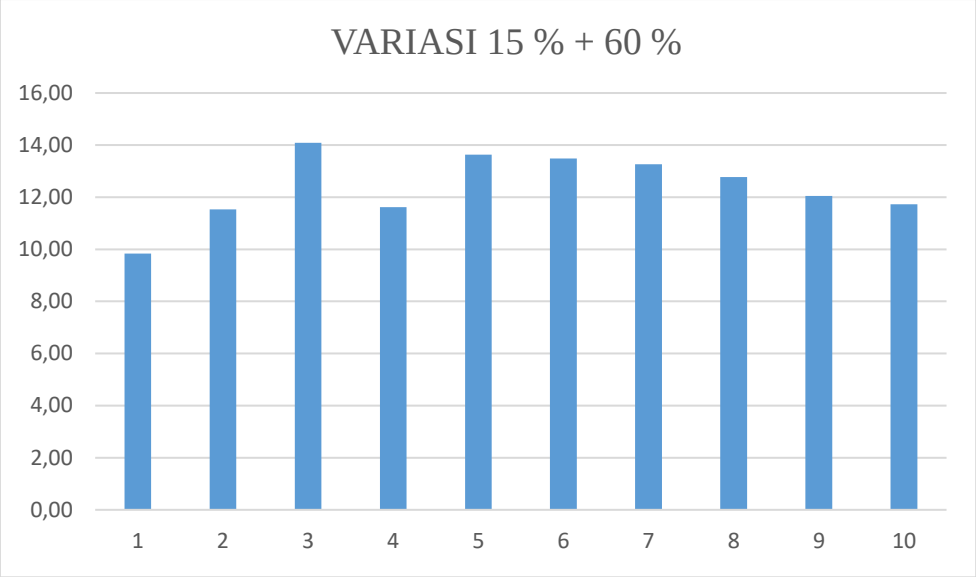
Figure 3. Graph of the Concrete Compressive Test Result



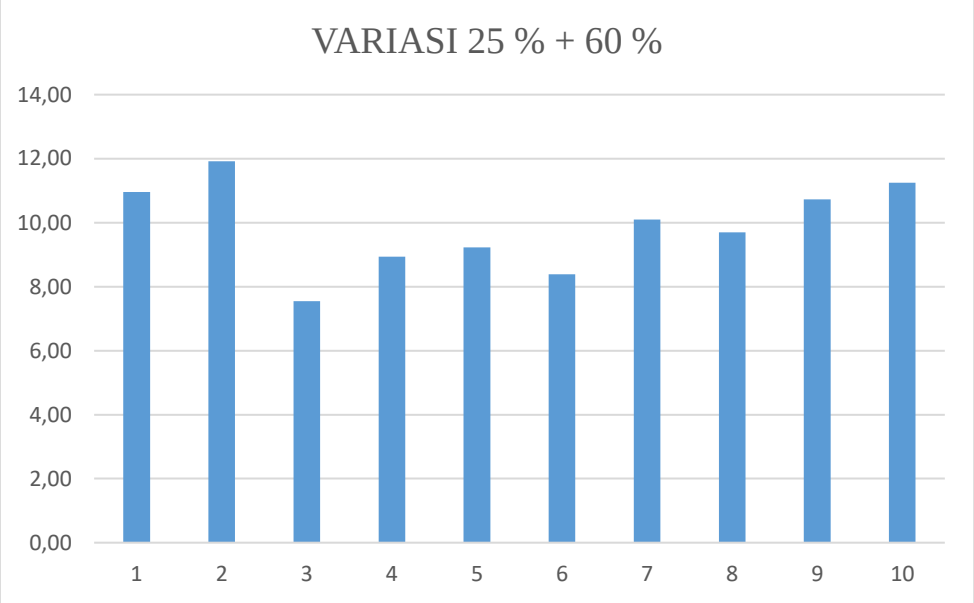
Source: Personal Data
Figure 4. Graph of Concrete Press Test Results A.



Source: Personal Data
Figure 5. Graph of Concrete Press Test Results B.



Source: Personal Data
Figure 6. Graph of Concrete Press Test Results C



Source: Personal Data
Figure 7. Concrete Press Test Results Graph D.

5. Conclusions and Suggestions

5.1. Conclusions

Based on the results of testing and analysis of the effect of extinguished lime as a substitute for cement and ceramic waste as a substitute for coarse aggregate in the concrete mixture on the compressive strength of concrete, the following conclusions are obtained:

1. Based on the results of research, concrete with additional substitution in the form of lime which is substituted into cement and ceramic waste which is substituted for kelad in coarse agrrates tends to experience a decrease in quality or compressive strength when compared to normal concrete without any added substitute materials.
2. Based on the results of the research, the highest compressive strength value of concrete mixed with substitution materials is the mixture or variation of 15% + 60% with the average results of 12.40 MPa.
3. Based on the results of research on concrete mixed with substitution materials, the highest slump value is in the 15% + 60% variation, which is 15 cm, and the lowest slump value is in the 15% + 60% variation, which is 8 cm, where these results are still in accordance with calculation of mix designs, namely between 60 - 180 mm.

4. Based on the results of research, concrete with a substitute material in the form of lime as a substitute for cement and crust waste as a substitute for coarse aggregate is more efficiently used for the manufacture of non-structural concrete.

5.2. Suggestion

Based on the results of observations and research, the suggestions that can be taken from this research are as follows:

1. When the research is carried out, it is necessary to have special accuracy in testing the materials, calculating the mix design, curing control, and testing the compressive strength, in order to get maximum results.
2. At the time of making the test material, it is necessary to pay attention to the good and homogeneous concrete mixing process, which is then followed by the compaction of the molds done carefully so that the resulting concrete does not experience porous in the concrete, if there is porous in the concrete it will affect the results of the compressive strength value. the concrete.

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The Cost Comparative Analysis of Steel Frame Bridge Installation Work Methodology Between Using Cranes and Using Launching Gantry in Muara Karang Combined Cycle Power Plant 400-500 MW Project

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Abstract

Electrical energy is one of the most important and vital human needs that cannot be separated from daily needs. The case study was taken from the Muara Karang Combined Cycle Power Plant 400-500 MW Project, which is part of a 35,000 MW governmental program that aims to fulfill electricity needs from Sabang to Merauke. In this project, a method of implementing steel-frame bridge installations will be sought in terms of cost. That way, later you will get an efficient installation implementation method. In this study, the authors used secondary data from literature and primary data that taken directly from field observations. Data processing uses statistical tests with the Stepwise method. The cost for the work method using the crane is IDR 367,212,450, while the cost for the work method using the launching gantry is IDR 321,868,085. In the percentage result of the steel frame bridge installation work method, the greatest effectiveness factor is Tool Reach (X11) of 94.5%. Whereas in the work method using launching gantry with the variable that has the greatest effectiveness is the Capacity of Tools Used 76.8%. Judging from these results the factors that have the highest effectiveness to influence the time performance in the implementation of the steel frame bridge installation work method are the tool factor and the material factor.

Keywords:
Effectiveness of Crane and Gantry Launching, Steel Frame Bridge Installationion and Work Implementation Methods,

1. Introduction

1.1. Background

Electrical energy is one of the most important and vital human needs that cannot be released from daily needs. Man can hardly do his existing work properly or meet his needs. Lack of electrical energy can interfere with human activity. Therefore the continuity and availability of electrical energy must be maintained. Currently, electricity needs are increasing as the population increases and technology and information advances.The use of electricity is no longer to meet social needs but also personal needs, therefore the power plant becomes the main focus of development as one of the most important infrastructures in meeting the shortage of electricity supply and needs attention to accelerate its development.(Widi Nugraha, 2018)

Muara Karang Hydroelectric Power Plant Project 400-500 MW, which is part of a government program of 35,000 MW that aims to meet electricity needs from sabang to merauke. In this project, electricity generated from the new plant (located in block 3) will then be flowed through the existing switchyard (in block 2 area) before being distributed out. The location of the new plant (block-3) and the old generator (block-2) are separated by a river with a span of ± 60m. Limited project locations and carrying out work among existing buildings. This steel frame bridge is a building structure that functions as a high voltage cable support from the project that is being built to the existing area of the switchyard which will later drain electricity for the needs of the community.Projects are organized efforts to achieve important goals, goals and expectations using budgets and available resources that must be completed within a certain period of time (Istimawan, 1996).On this basis, it is necessary to analyze the method of implementation. That way there will be a more efficient method of installation work.

Based on the above, the authors will conduct an assessment of the comparative analysis of the method of installation of steel frame bridges using cranes and launching gantry with limited land. The results of this study are expected to help to reverence and consideration of the method of installation of steel frame bridges on future projects.

1.2. Identify Problem

There are indications of problems related to the cost and limitations of the land used. In the selection of heavy equipment that should use a 150 ton crane with a lifted load of 23.26 tons spans 30 m on both segments of the steel frame bridge. But due to the range required on the method of implementing the installation of a long steel frame bridge, then for a crane 150 tons is not recommended because the angle is too large. So the selection of cranes to the west of block 3 is using a 300 ton crane and east of 360 tons with a rental of Rp 367,212,450 million already all in. Problems related to land limitations include material storage, range of bridge material and tool assembly in the implementation of steel frame bridge installations.

1.3. Problem Formulation

Based on the identification of the above problems, it can be formulated the following problems:

1. Which is the use of more economical installation equipment between crane and gantrylaunching on the implementation of steel frame bridge installation at Muara Karang Hydroelectric Power Plant Project 400-500 MW?
2. How effective are the two tools used in the installation of the steel frame bridge?

1.4. Research Objectives

The intentions and objectives of this study are:

1. Knowing the method of implementation of more economical installation between crane and gantry launching on the implementation of steel frame bridge installation in Muara Karang Hydroelectric Power Plant Project 400-500 MW.
2. Knowing the effectiveness of both tools used in the installation of steel frame bridges in Muara Karang Hydroelectric Power Plant Project 400-500 MW.

2. Methodology

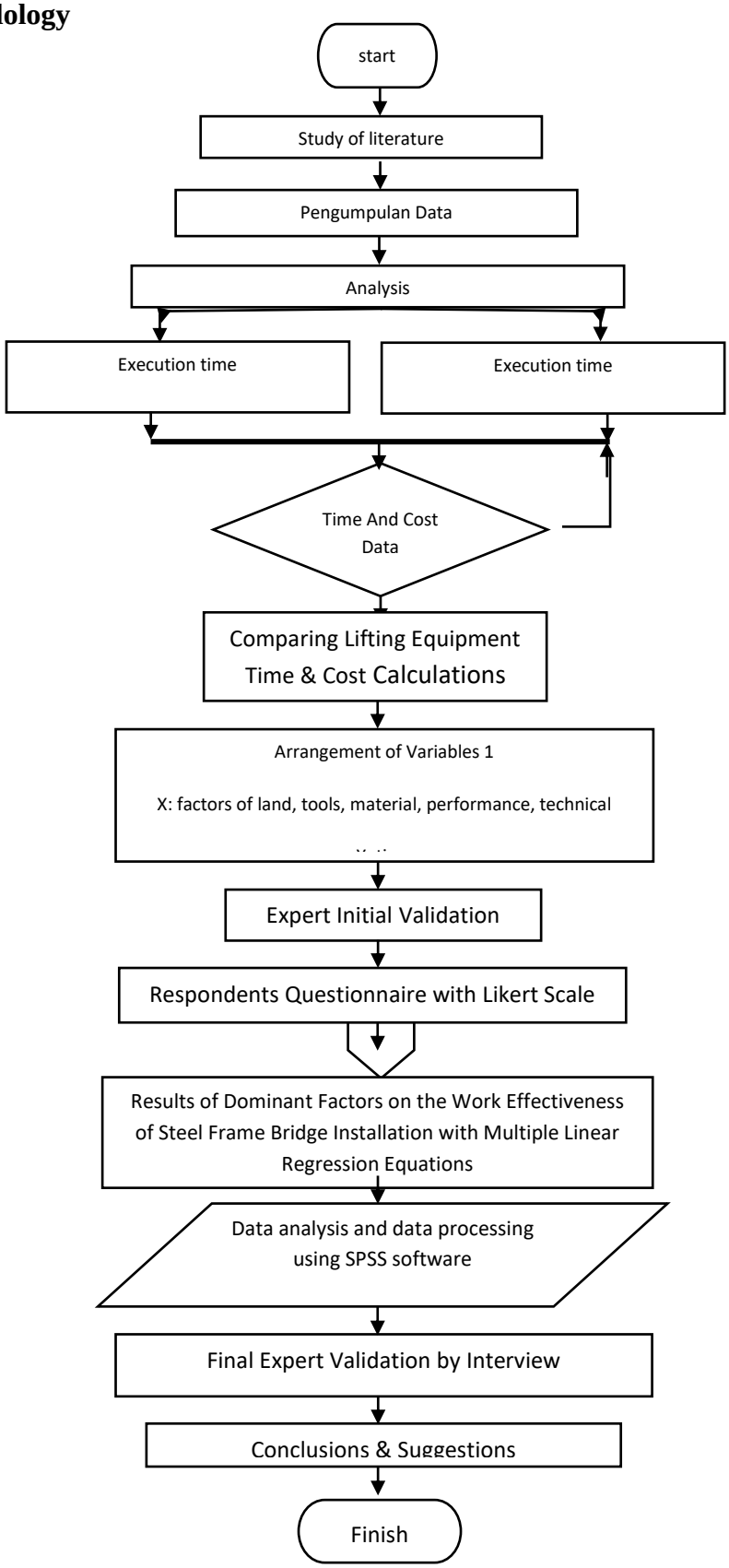

Figure .1 Research FlowChart
Source: Self-Processed Products, 2020

In general, the flow chart for the final task is:

1. Problem Overview
   Formula the problem from the background presented, then do a literature study on the problem that has been set. The next stage of the method will be used this research.
2. Data Collection
   Data collection is done at the research method stage. The data used in this study is primary and secondary data.
3. Primary Data and Secondary Data
   The primary data used in this study was field surveys and interviews, then questionnaires were conducted. Secondary data obtained from project data, journals and books.
4. Preparation of Questionnaire:
   a.Phase I Questionnaire: Preparation of phase l questionnaire intended to ask experts to review questionnaires that have been compiled by researchers.
   b. Phase II Questionnaire: The dissemination of phase 2 questionnaire was given to 35 respondents.
   c. Input questionnaire data: Here the researchers re-collected the questionnaire that has been filled in by the respondent to be further analyzed.
5. Data Processing
   After the questionnaire, the data that the questionnaire results are processed method with statistical analysis, namely using the help of statical program for social science (SPSS) software.
6. Data Processing Results
   The result of processing data from the help of spss software, can know the dominant variables.
7. Conclusions and Suggestions
   After getting the results of data processing, then the researchers make conclusions and suggestions.

3. Result and Discussion

In this chapter will be discussed about the results of research that has been done about the influential variables facing the use of more effective and economical tools in each method used in the installation of steel frame bridges.

3.1. Bridge Structure Data

The structure of the steel frame bridge to be built in muara karang hydropower project 400-500 MW has the following data:

Span length : 60 m
Structure Weight : ± 45 tons

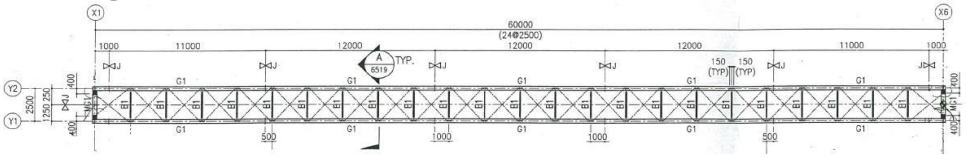

Figure 2. Steel Frame Bridge
Source: Self-Processed Products, 2020

3.2. Crane Time Analysis

Table 1. Total Time of Implementation of Crane Work

No	Job	Time	Unit
1	Mob Demobilization	480	Minutes
2	Crane Preparation and Setting	480	Minutes
3	Steel Frame Bridge Intalasi	275	Minutes
4	Welding	20	Minutes
5	Realease	25	Minutes
	Total	1280	Minutes

Source: Self-Processed Products, 2020

The total cycle time required to install a 60 meter span steel frame bridge using a crane is 1,280 minutes = 3 days with 8 working hours in 1 day. This process only includes erection work and does not include ironwork and casting work.

3.3. Time Analysis Using Launching Gantry

Table 2. Total Time of Work Using Gantry Launching

No	Job	Time	Unit
1	Mob Demobilization	960	Minutes
2	Gantry Launching Preparation and Setting	5280	Minutes
3	Steel Frame Bridge Intalasi	515	Minutes
4	Welding and Uninstall hydraulic jack	27	Minutes
5	Realease	25	Minutes
6	Realease gantry launching structure	5280	Minutes
	Total	12.087	Minutes

Source: Self-Processed Products, 2020

So the total time required on the installation of a 30-meter steel frame bridge using gantry launching is 12,087 minutes= 26 days, One day works 8 hours.

3.4. Cost Analysis Of Work Methods Using Crane

Table 3. Total Recapitulation of Cost Budget Plan

No	DESCRIPTION: 10	AMOUNT
No	Description	TOTAL PRICE (RP)
I	PREPARATORY WORK	
	Sign k3	
	MobDemob	
Ii	STEEL FRAME BRIDGE	
	Installation of steel frame bridges	
A	Total	333,829.500
B	ROUNDED	333,829.500
C	VAT 10 %	33,382.95
D	GRAND TOTAL	367,212.450

Source: Self-Processed Products, 2020

From the table above can be concluded that the result of the calculation of the cost of the construction of the bridge installation (RAB) is obtained amounting to IDR. 367,212,450.

3.5. Cost Analysis Of Work Method Using Gantry Launching

Table 4. Total Recapitulation of Cost Budget Plan

No	DESCRIPTION: 10	AMOUNT
No	Description	TOTAL PRICE (RP)
I	PREPARATORY WORK	
	Sign k3	
	MobDemob	
Ii	STEEL FRAME BRIDGE	
	Installation of steel frame bridges	
A	Total	292,607.350
B	ROUNDED	292,607.350
C	VAT 10 %	29,260.74
D	GRAND TOTAL	321,868.085

Source: Self-Processed Products, 2020

The above cost budget plan, totaling IDR. 321,868,085 requires 26 days implementation time (assuming that the number of working hours in 1 day is 8 working hours). When compared to the previous method of using cranes, the cost of installing a steel frame bridge using gantry launching is cheaper. This is because in the previous method the rental price of the tool was more expensive.

3.6. Phase I Data Collection And Analysis (Expert Validation)

3.6.1. Expert Profiles

This first stage data collection is done by distributing questionnaires to 5 experts with minimum experience ≥5 years for s2 and ≥10 years experience for bachelor's and good reputation.

3.6.2. Crane Multiple Linear Regression Analysis

Once known the dominant variables of the correlation value in the next factor analysis are performed regression analysis. Regression analysis is a way or technique to find a relationship between one variable and another expressed in the form of mathematical equations in a functionary relationship

Table 5. Crane Simultaneous Test Results (F-Test)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	125.767	1	125.767	70.578	.000[b]
	Residual	58.804	33	1.782		
	Total	184.571	34			
2	Regression	148.158	2	74.079	65.101	.000[c]
	Residual	36.413	32	1.138		
	Total	184.571	34			
3	Regression	158.283	3	52.761	62.218	.000[d]
	Residual	26.288	31	.848		
	Total	184.571	34			

a. Dependent Variable: Y
b. Predictors: (Constant), X11
c. Predictors: (Constant), X11, X7
d. Predictors: (Constant), X11, X7, X1

Source : Processed Results Software processed statistical data

From table 5, The calculated F value obtained in model 3 is 62,218 and the value of F table with a confidence level of 95% obtained from table F with a significant rate of 5%. For (df1) k-1 = 3-1 = 2 and (df2) n-

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k = 35-3 = 32, the meal shows the table's F value of 2,911. This indicates F count > F table then the signification value is definitely smaller than 0.05 which is 0,000 which means significant influence.

Table 6. Crane Partial Test Results (T-Test)

Coefficients a

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	Q	Sig.
1	(Constant)	4.317	.876		4.927	.000
	X11	1.830	.218	.825	8.401	.000
2	(Constant)	3.463	.726		4.769	.000
	X11	1.325	.208	.598	6.368	.000
	X7	.770	.174	.416	4.436	.000
3	(Constant)	3.218	.631		5.101	.000
	X11	.945	.211	.426	4.490	.000
	X7	.574	.160	.310	3.582	.001
	X1	.667	.193	.340	3.455	.002

a. Dependent Variable: Y

Source : Processed Results Software processed statistical data

In table 6, model 3 indicates there is an independent variable that affects the depeden variable i.e. signification value < 0.05 or the value of T count > T table, i.e. table Value T = 2,037. The above data shows that k=3 and n=35. Inserted into the formula it will generate a number (0.05/2; 35-3-1) = (0.025;31). Obtained table T value of 2,037, it is concluded that variable Y (Crane Method) is affected 1 by variables X11 (Tool Range), X7 (Steel Frame Bridge Structure Length) and X1 (Project Entrance Access). The size of the T value indicates the amount of correlation of each variable. For the more dominant variable is variable X11 because it has a greater T value in comparison to the others. From table 4. 34 get regression equations, namely:

Y1 = 3.218 + 0.945 X11 + 0.574 X7 + 0.667 X1

A constant of 3,218 indicates that if there is no X data value then the Y data value will be 3,218. A positive sign (+) indicates that the effect of X data on Y is directly proportional which means that if the X data value is enlarged then the value of the Y data will increase as well, and vice versa.

The explanation of the regression equation above is as follows:

a. 1 Constant of 3,218 means that if all variables are constant value then the value of Y1 will change by itself as big as the constant value.
b. Tool Range variable regression coefficient (X11) of 0.945 means that if X11 experiences a one-unit increase, then performance (Y) with crane method will increase by 94.5%.
c. Variable regression coefficient of Steel Frame Bridge Structure Length (X7) of 0.574 means that if X7 experiences a one-unit increase, then performance (Y) with crane method will increase by 57.4%.
d. Project Entrance Access variable regression coefficient (X1) of 0.667 means that if X1 increases by one unit, then performance (Y) with crane method will increase by 66.7%.

3.6.2. Gantry Launching Linear Regression Analysis

Once known the dominant variables of the correlation value in the next factor analysis are performed regression analysis. Regression analysis is a way or technique to find a relationship between one variable and another expressed in the form of mathematical equations in functional relationships.

Table 7. Summary Launching Gantry Capital Results

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827[a]	.683	.674	1.23709
2	.901[b]	.811	.799	.96998
3	.920[c]	.846	.831	.88971

a. Predictors: (Constant), X28
b. Predictors: (Constant), X28, X12
c. Predictors: (Constant), X28, X12, X7

Source : Processed Results Software processed statistical data

In Table 7, it shows there are 3 regression models resulting from the determination coefficient test, but the best regression modal is the number 3 regression model consisting of 3 variables because it has a greater R2 value than other models which is 0.846 meaning of depeden variable variability that can be explained by

variability. The independent variable is 84.6 so the model is quite good, while the remaining 15.4% is explained by other variables that are not included in the regression model.

Table 8. Gantry Launching Simultaneous Test Results (F-Test)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	109.040	1	109.040	71.250	.000[b]
	Residual	50.503	33	1.530		
	Total	159.543	34			
2	Regression	129.435	2	64.718	68.785	.000[c]
	Residual	30.108	32	.941		
	Total	159.543	34			
3	Regression	135.004	3	45.001	56.850	.000[d]
	Residual	24.539	31	.792		
	Total	159.543	34			

a. Dependent Variable: Y
b. Predictors: (Constant), X28
c. Predictors: (Constant), X28, X12
d. Predictors: (Constant), X28, X12, X7

Source : Processed Results Software processed statistical data

From table 8, the calculated F value obtained in model 3 is 56,850 and the value of F of the table with a confidence level of 95% obtained from table F with a significant level of 5%. For (df1) k-1 = 3-1 = 2 and (df2) n-k = 35-3 = 32, the meal shows the table's F value of 2,911. This indicates F count > F table then the signification value is definitely smaller than 0.05 which is 0,000 which means significant influence.

Table 9. Gantry Launching T-Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	Q	Sig.
1	(Constant)	5.528	.694		7.965	.000
	X28	1.564	.185	.827	8.441	.000
2	(Constant)	4.251	.609		6.974	.000
	X28	1.051	.182	.556	5.764	.000
	X12	.915	.196	.449	4.656	.000
3	(Constant)	3.993	.567		7.038	.000
	X28	.694	.215	.367	3.234	.003
	X12	.768	.189	.377	4.072	.000
	X7	.574	.216	.304	2.652	.012

a. Dependent Variable: Y

source : Processed Results Software processed statistical data

In table 9, model 3 indicates there is an independent variable that affects the depeden variable i.e. signification value < 0.05 or the calculated T value > T of the table, i.e. table Value T = 2,037. The above data shows that k=3 and n=35. Inserted into the formula it will generate a number (0.05/2; 35-3-1) = (0.025;31). A table T value of 2,037 is obtained, so it is concluded that variable Y (Gantry Launching Method) is affected 1 by variables X28 (Natural Conditions), X12 (Tool Capacity Used) and X7 (Length of Steel Frame Bridge Structure). The size of the T value indicates the amount of correlation of each variable. For the more dominant variable is variable X12 because it has a greater T value in comparison to the others. From the table is obtained regression equations, namely:

Y1 = 3.993 + 0.694 X28 + 0.768 X12 + 0.574 X7

A constant of 3,993 indicates that if there is no X data value then the Y data value will be 3,993. A positive sign (+) indicates that the effect of X data on Y is directly proportional which means that if the X data value is enlarged then the value of the Y data will increase as well, and vice versa.

The explanation of the regression equation above is as follows:

a. A constant of 3,993 means that if all variables are constant value then the value of Y1 will change by itself as big as the constant value.

Natural Condition variable regression coefficient (X28) of 0.694 means that if X28 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 69.4%.

Variable regression coefficient of Used Tool Capacity (X12) of 0.768 means that if X7 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 76.8%.

Variable regression coefficient of Steel Frame Bridge Structure Length (X7) of 0.574 means that if X1 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 57.4

4. Conclusions and Suggestions

4.1. Conclusions

Based on the analysis that has been done in this study, it can be concluded that the method of installation work using cranes is superior to the method of work using launching gantry in terms of time. Meanwhile, in terms of the cost of working methods using launching gantry is cheaper than using cranes.

Table 10. Cost and Time Analysis Results

No	Variable	Installation Work Method		Difference
		Crane	Launching Gantry	
1	Cost	(T&B)	Average price per night	Average price per night
2	Time	3 Days	26 Days	23 Days

Source : Processed Results Software processed statistical data

Based on the analysis that has been done in this study that the effectiveness that affects the implementation of the method of installation of steel frame bridges using cranes against time is tool factor (X11) by 94.5% and effectiveness that affects the implementation of steel frame bridge installation method using gantry launching against time is Tool Factor (X12) by 76.8%.

4.2. Suggestion

The advice that can be given for the method of installation of steel frame bridge based on the results of this study is as follows:

1. The method of implementation with gantry launching can be used as a reference on the implementation of bridge construction work in certain projects, especially in limited locations or land that can not be reached by large capacity cranes, but must still be carried out analysis according to the conditions in the field.
2. Further research can be continued about K3 in the process of carrying out work especially on bridge building.

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Performance Analysis Of Trans Patriot Bus Impact Covid-19 (Terminal Bekasi - Harapan Indah Route)

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Abstract

As the population of the former city grows, the movement of the people in it increases. Provision of mass transportation or Trans Patriot buses is needed to anticipate the congestion that will occur by providing a cheap, fast and safe bus type that can be an alternative. Therefore, it is necessary to conduct research on the performance and quality of service to determine the level of passenger satisfaction with the performance of the Trans Patriot bus on the Bekasi - Harapan Indah Terminal route. From the comparison of the operational performance of the Trans Patiot buses before Covid 19 and the adaptation of new habits, the Comparison of the performance of the Trans Patriot bus for the Bekasi Terminal - Harapan Indah route before Covid 19 and the adaptation of new habits has increased in load factors, headway, travel time and travel speed, This increase is very good in providing services for Trans Patriot bus users. From the results of the questionnaire service performance level obtained from Trans Patriot bus users for the Bekasi Terminal - Harapan Indah route, which stated that the Trans Patriot bus performance was very good at 9%, good at 33%, good enough at 44%, less good at get 11% and not good at 4% and the level of user satisfaction states Very Satisfied at 9.9%, Satisfied at 41.4%, Quite Satisfied 39.6%, Less Satisfied at 8.9% and Not Satisfied 0.4%. This research is expected to be a reference or material for the Bekasi city government to take a policy so that the performance and service of Trans Patriot buses will increase in reducing congestion in the city of Bekasi.

Keywords
Importance Performance, Performance and Service of Trans Patriot buses Importance Performance.

1. Introduction

As the population continues to increase, the number of activities of the population in an effort to meet the needs of each day implies a journey / movement from one place to another. In carrying out human movement activities using transportation facilities and infrastructure, the increase in population and private vehicles makes public transportation increasingly abandoned by the community.

The purpose of writing this research is want to know service satisfaction and service performance as well as find out operational performance before covid 19 and adaptation of new habits.

2. Theoretical basis

Bus Rapid Transit is a customer-oriented form of transportation that combines stops, vehicles, planning and elements of the transportation system into a guided system that has a unique identity. Bus Rapid Transit has a number of conveniences compared to other modes of transportation, including those related to routes

According to Miller et al., (2008) BRT routes can be tailored to the needs of users, government policies and other dynamic conditions. BRT systems in general include:

Pick up and drop passengers fast.
Efficient fare collection.
Convenient stops and sta.tions
Clean bus technology.
Mode integration.
Modern marketing identity.
Excellent user service.

2.1. Service

According to Haksever, (2000) states that service or service is defined as an economy that produces time, place, form and psychological use. According to Gray & Mirza, (1979)Service quality is a condition or characteristic of the transportation expected by users, which consists of elements such as:

a. Safety.

b. Comfort.
c. Convenience.
d. Reliability.
e. Comparison of costs.
f. Efficiency.

2.2. Public Transport Performance

Public transportation performance is the performance result of public transportation serving all community activities for traveling or doing activities. To determine the level of public transport services, it is necessary to have indicators regulating the performance of these public transports. Based on the decision of the Director General of Land Transportation No. SK. 687 / AJ.206 / DRJD / 2002, the performance of public transport services can be assessed from the following indicators:

a. Load factor

It is the ratio between the number of passengers carried in the vehicle to the total seating capacity of passengers in the vehicle for a certain period of time.

$$LF = \frac{Psg}{c} x\ 100\% \quad \text{.....(1)}$$

Where:

Psg : The number of passengers carried
C : Passenger seating capacity
Lf : Load factor (%)

b. Time Between (Headway)

Headway is the time between one vehicle and another vehicle that is loaded behind it on one route or the difference in arrival time between one vehicle and the next vehicle.

$$H\ \frac{60}{Q} \text{.....(2)}$$

Where:
H: Headway (minute)
Q: frequency (vehicles per hour)

c. Travel Speed

Travel speed is the average vehicle from the starting point of departure to the end point of the route.

$$travel\ speed = \frac{the\ distance\ between\ the\ terminals}{travel\ time\ between\ terminals} \text{..... (3)}$$

d. Travel time

Travel time is the time it takes for a vehicle to pass through the observed road segment, including stopping time to raise and lower passengers and delay due to obstacles, travel time is calculated with a stopwatch from the initial departure to the destination.

e. Service time

This is the time during which vehicles on a route are still operating. The time is calculated from the start of the vehicle operating in the morning to the last operation in the afternoon or evening.

f. Service frequency

This is the number of bus vehicle departures that pass at one point (for example a bus stop) in units of vehicles per hour.

$$Q\ \frac{n}{T} \text{..... (4)}$$

Where:
Q= frequency
n = number of vehicles
T = time per hour (60 minutes)

g. The number of vehicles in operation

The number of operating fleets is the number of public passenger vehicles on each route that operate during service time.

2.3. Minimum Service Standards for the Directorate General of Land Transportation

To find out the performance of public transportation services, there are several elements that can be used as a reference and describe the characteristics of the expected transportation as determined by the government or the PO Perum PPD (Directorate General of Land Transportation) in terms of minimum service standards for users of the Trans Patriot public transport bus, both from in terms of quantity and quality of transportation, it can be assumed as in the table below:

Table 1. Assessment Criteria

No.	Criteria	Weight
1	A	3
2	B	2
3	C	1

Source: Directorate General of Land Transportation

Table 2. Service Standards According to the Directorate General of Land Transportation

No.	Indicator	C	B	A
1	Load factor during peak hours	> 1	0.8-1	<1
2	Travel speed (km / h)	<5	5-10	> 10
3	Headway time (minutes)	> 15	10-15	<10
4	Travel Time (minutes / km)	> 12	6-12	<6
5	Service time (hours)	<13	13-15	15
6	Frequency	<4	4-6	> 6
7	Number of operating vehicles (%)	<82	82-100	> 100
8	Passenger waiting time (minutes)	> 30	20-30	<20

Source: Directorate General of Land Transportation

2.4. Importance Performance Analysis Method

IPA (Importance Performance Analysis) is used to map the relationship between performance and the importance of each attribute offered and the gap between performance and expectations of the attributes that have been determined.In this technique, respondents are asked to rate the level of performance and importance of the services provided by the service provider.

Figure 1. A Cartesian Diagram of the Natural Science Method

Source: (Nengkoda et al., 2011)

The explanation of the Cartesian quadrant diagram is as follows:

a. Quadrant I (Top Priority)

In this quadrant, there are things that are considered important and expected by service users, but the performance provided by service providers to users is not satisfactory, so the performance needs to be improved to satisfy service users.

b. Quadrant II (Maintain Achievement)

In this quadrant there are things that are considered important and expected by service users and have high performance so that it needs to be maintained by service providers.

c. Quadrant III (Low Priority)

In this awareness there are things that are considered to have a low level of performance and are less important or not really expected by service users so that service providers do not need to prioritize or pay more attention to these things.

d. Quadrant IV (Excessive)

In this awareness, there are things that are considered not too important and that are not really expected by service users so that service providers are better off diverting things included in these factors to factors that have a higher priority level.

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3. Methodology

This research method uses quantitative methods. The data obtained by using a survey of load factors, headway, travel speed, travel time, service time and number of operating vehicles and by distributing questionnaires. The number of samples used in distributing questionnaires is 100 respondents using the formula Lemesshow for the unknown population

$$n \frac{Z^2 \; x \; P(1-P)}{(1+N(e)^2)} \text{.. ....} (6)$$

Where :
n = Number of samples
Z = z score at 95% confidence = 1.96
p = maximum estimate = 0.5
d = Alpha (0.10) or sampling error = 10%

4. Results and Analysis

4.1. Operational performance adaptation to new habits

This analysis will identify the level of operational performance during the Covid-19 pandemic on the trans patriot bus at the Bekasi-Harapan Indah terminal. The following are the results of the data during the survey:

a. Load Factor

From the results of field observations for the route under review, it has been obtained the average number of passengers on the trans patriot public transport bus. The load factor calculation is carried out for 2 days on Monday and Saturday.

Table 3. Load Factor

No.	Route	Day	Time	Average Load factor
1	Bekasi Terminal - Harapan Indah	Monday	Morning	0.81
2	Bekasi Terminal - Harapan Indah	Monday	Noon	0.31
3	Bekasi Terminal - Harapan Indah	Monday	Afternoon	0.75
4	Harapan Indah - Bekasi Terminal	Monday	Morning	0.69
5	Harapan Indah - Bekasi Terminal	Monday	Noon	0.30
6	Harapan Indah - Bekasi Terminal	Monday	Afternoon	0.68
7	Bekasi Terminal - Harapan Indah	Saturday	Morning	0.64
8	Bekasi Terminal - Harapan Indah	Saturday	Morning	0.23
9	Bekasi Terminal - Harapan Indah	Saturday	Noon	0.24
10	Harapan Indah - Bekasi Terminal	Saturday	Morning	0.45
11	Harapan Indah - Bekasi Terminal	Saturday	Noon	0.30
12	Harapan Indah - Bekasi Terminal	Saturday	afternoon	0.20
	Average			0.47

In terms of the standard used, the ideal load factor for public transport is 0.8. While the results obtained, the average load factor is 0.47, so the value of the trans Patriot bus load factor on this route shows a good criteria value.

b. Time Between (Headway)

The average headway for transpatriot buses is 17 minutes, if you look at it from the headway point of view of the level of public transport services, the trans Patriot bus is in the bad category because based on the standard it is used more than> 15 minutes.

c. Travel time

The result of the average obtained from the research for the trans-patriot bus travel time is 3.5 minutes / km, based on the standard indicators used, it is known that the trans-patriot bus vehicle travel time is still in good condition, because the value is smaller than the standard used. used that is <6 minutes / km.

d. Travel Speed

The results of the average travel speed of the Trans Patriot buses obtained 46 km / hour, this result shows that the service level of the Trans Patriot public transport buses is in good condition because based on the standards used, if> 10 km / hour is categorized as good.

e. Frequency

The average frequency of trans patriot buses is 3 vehicles / hour. From these results, it can be seen that the frequency of trans-patriot bus vehicles on this route is in poor criteria because it is in accordance with the standards used when the category is lacking, namely in the value range <4 vehicles / hour.

f. Service Time

The service time of the Trans Patriot public transport bus for the Bekasi terminal route - Harapan Indah is 15 hours / day. The criteria for service time can be said to be in good status if the public transport service lasts> 15 hours. So that the trans Patriot public transport bus service if the value of the service time for the Bekasi-Harapan Indah terminal route is still in quite good condition.

g. Number of Operating Vehicles

Based on field observations, the number of trans patriot bus vehicles operating on the Bekasi-Harapan Indah terminal route is 9 buses and 9 buses operating. Based on the standard of public transport services used, the number of vehicles operating for trans patriot buses is 100% percent, so the criteria are still quite good.

h. Beginning and End of Service Time

The service time of all Trans Patriot buses for the Bekasi-Harapan Indah terminal route in one day starts at 05:00 WIB and ends at 21:00 WIB (15 hours / day). Based on the standards used, the assessment of the service level of the Trans Patriot bus from the start and end of the service time includes good criteria.

Table 4. Recapitulation of performance levels of trans patriot public transport buses

No.	Indicator	Big	Unit	Assessment criteria			Results Criteria	
				Well (3)	Moderate (2)	Less (1)		
1	Load factor on	0.47	%	<0.8	0.8-1	> 1	3	Well
2	Time Between / headway	15	Minute	<0.10	10-15	> 15	1	Less
3	Travel time	3.52	Minutes / hour	<6	6-12	> 12	3	Well
4	Service Time	15	Hour	> 15	13-15	<13	2	Moderate
5	Frequency	3	Vehicle / hour	> 6	4-6	<4	1	Less
6	Travel Speed	46	Km / hour	> 10	5-10	<5	3	Well
7	Number of Operating Vehicles	100	%	> 100	85-100	<82	2	Moderate
8	Beginning and End of Service Time	05-21		05-21	05-20	05-18	3	Well
		Total					18	Well

Source: Secondary Data, 2020

4.2. Comparison of Operational Performance Before Covid and Adaptation to New Habits

This analysis is to compare the operational performance of the Trans Patriot bus before Covid 19 with the adaptation of new habits. The details are as follows:

Table 5. Comparison of operational performance before Covid and adaptation of new habits

Variable	Before covid	Adapt new habits	Information
Load Factor	15-20%	35-40%	To increase
Headway (minutes)	20	17	To increase
Frequency (vehicle / hour)	3	3	Permanent
Service time (hours)	15	15	Permanent
Travel Time (minutes)	75	65	To increase
Bus Fleet	9	9	Permanent
Travel Speed (km / h)	46	46	Permanent

Source: Secondary Data, 2020

From the results of the comparison above, the operational performance of the Trans Patriot bus has increased from before Covid 19, the increase in the Trans Patriot bus is quite good, seeing that the Trans Patriot bus load factor has started to increase which indicates the Bekasi community has trusted the Trans Patriot bus as a good public transportation.

4.3. Questionnaire Data Analysis

4.3.1. Validity test

The validity test is used to measure whether a statement is appropriate to be used in measuring a certain aspect. Validity is indicated by the value of the correlation. A question item is declared valid if the calculated correlation value> table correlation value (r count> r table). In this study, the number of respondents (n) was 100 respondents with a confidence level of 95% (r table) = 0.195. based on the results of each indicator to the total construct score of each variable shows significant results, namely r count> r table. So it can be concluded that all. The question item is declared valid.

Table 6. Validity Test Results

Variable	R count	R table value	Sig value.	Decision	Variable	R count	R table value	Sig value.	Decision
X1	0.609	0.197	0	Valid	Y1	0.518	0.197	0	Valid
X2	0.563	0.197	0	Valid	Y2	0.575	0.197	0	Valid
X3	0.379	0.197	0	Valid	Y3	0.510	0.197	0	Valid
X4	0.740	0.197	0	Valid	Y4	0.570	0.197	0	Valid
X5	0.640	0.197	0	Valid	Y5	0.682	0.197	0	Valid
X6	0.576	0.197	0	Valid	Y6	0.519	0.197	0	Valid
X7	0.450	0.197	0	Valid	Y7	0.627	0.197	0	Valid
X8	0.675	0.197	0	Valid	Y8	0.695	0.197	0	Valid
X9	0.578	0.197	0	Valid	Y9	0.602	0.197	0	Valid
X10	0.595	0.197	0	Valid	Y10	0.695	0.197	0	Valid
X11	0.679	0.197	0	Valid	Y11	0.657	0.197	0	Valid
X12	0.684	0.197	0	Valid	Y12	0.602	0.197	0	Valid
X13	0.624	0.197	0	Valid	Y13	0.695	0.197	0	Valid
X14	0.700	0.197	0	Valid	Y14	0.564	0.197	0	Valid

Source: SPSS Processing Results

4.3.2. Reliability Test

Reliability test is used to measure the consistency of the construct / research variable. A variable is said to be reliable if the respondent's answer to the question is consistent or stable over time. The level of reliability of a research variable construct can be seen from the results of the Croncbach Alpha (α) statistic. A variable is said to be realistic if the Cronbach Alpha value is ≥ 0.60.

Based on the results of the calculation of all variables, it can be said to be reliable, namely having a Crinbach Alpha (α) ≥ 0.60, so it can be concluded that the questionnaire will provide consistency of the same measurement results if carried out in a different time context. Therefore, each variable concept is suitable for use as a measuring tool.

Table 7. Reliability Test Results

Variable	Reability Coefficient	Cronbach Alpha	Information
X (Performance)	14 question items	0871	Reliable
Y (Satisfaction)	14 question items	0.857	Reliable

4.3.3. Importance Performance Analysis

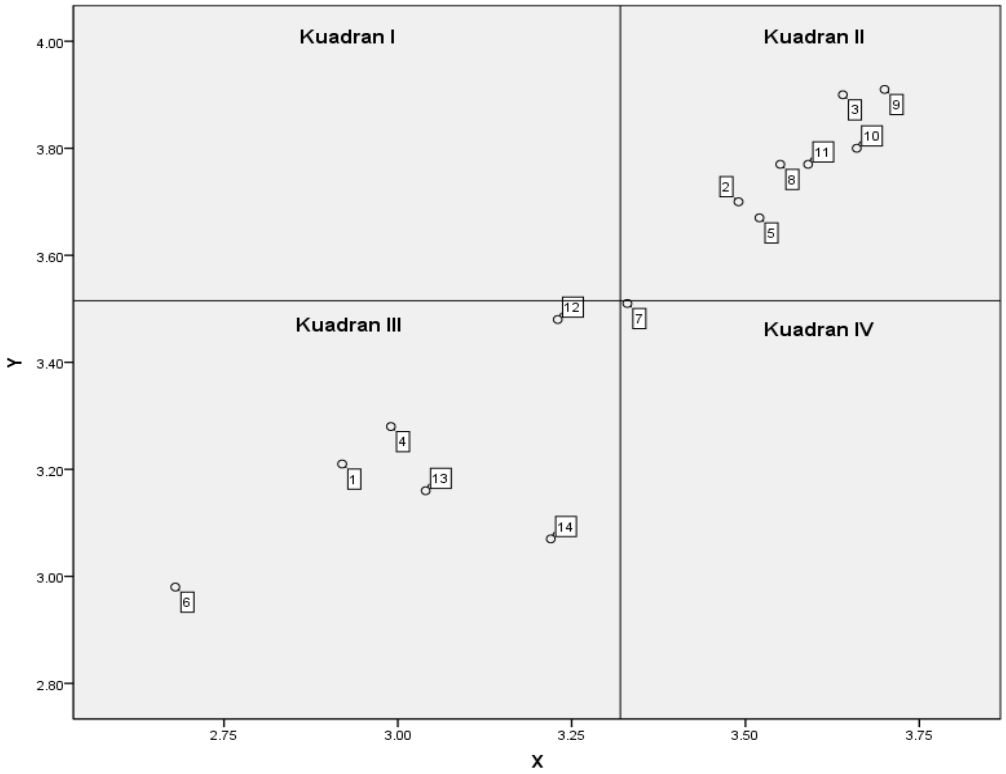
Analysis of the questionnaire data in this study using the IPA method. This was done to find out the respondent's opinion regarding the performance and level of user satisfaction with the condition of the object in question. The respondents referred to in this study were users of the Trans Patriot Bus Terminal Bekasi - Harapan Indah route. From the results of respondents' assessment of the questionnaire, the level of performance and level of satisfaction was obtained. in the form of a Cartesian diagram as follows:

Table 8. Level of Conformity Between Performance Level and Satisfaction Level

No.	INDICATOR	Rating Score		Level of Conformity
		Performance	Satisfaction	
1	Availability of safety facilities (APAR, glass breaking equipment, and emergency exits)	292	321	90.97%
2	The Trans Patriot Bus door can be closed perfectly	349	370	94.32%
3	Availability of surveillance cameras (CCTV) on the bus	364	390	93.33%
4	Availability of information (in the form of stickers) including the telephone number and SMS of the complaint	299	328	91.16%
5	The lights on the bus are functioning properly	352	367	95.91%
6	Adjust the time of arrival and departure to the schedule	268	298	89.93%
7	Friendliness and honesty of the bus conductor in providing service.	333	351	94.87%
8	Clean seating and cabin areas are available	355	377	94.16%
9	The availability of an air conditioning system that maintains room temperature	370	391	94.63%
10	Availability of handrails for standing passengers	366	380	96.32%
11	Availability of Trans Patriot bus route maps	359	377	95.23%
12	Availability of information on the nearest Trans Patriot Bus stop	323	348	92.82%
13	The availability of a special room for passengers who bring wheelchairs	304	316	96.20%
14	Availability of priority seating	322	307	104.89%

Source: Questionnaire Processing Results

Figure 2. Kartecius Diagram of Performance Level and Satisfaction Level



Source: SPSS 2020 processing

After obtaining the results from the Kartecius diagram shown in Figure 1, it can be determined the level of performance and level of satisfaction, among others, as follows .

Quadrant II (Maintain Achievement)

The indicators contained in Ku Awareness II include:

a. Trans patriot bus door can be closed perfectly.
b. Availability of surveillance cameras (CCTV) on the bus.
c. The lights on the bus are functioning properly
d. Friendliness and honesty of the bus conductor in providing services.
e. The availability of an air conditioning system (AC) that maintains room temperature.
f. Availability of handrails for standing passengers
g. Availability of trans patriot bus route maps

Quadrant III (Low Priority)

The indicators contained in Ku Awareness III include:

a. Availability of safety facilities (APAR, glass breaking equipment, and emergency exits.
b. Customizable arrival and departure times with schedules.
c. Availability of information on the nearest trans patriot bus stop.
d. The availability of a special room for passengers who bring wheelchairs.
e. Availability of priority seating.
f. Availability of information (in the form of stickers) including the telephone number and text of the complaint

Quadrant IV (Excessive Priority)

The indicators contained in Ku Awareness IV include:

a. The availability of a clean cabin area.

5. Conclusion

Based on the results of the analysis and calculation of data and observations made during data collection, it can be concluded as follows:

1. The performance of the Trans Patriot bus for the Bekasi - Harapan Indah Terminal route which refers to the minimum service standard indicator of the Directorate General of land transportation, shows that the average result for performance is good. In other words, the quality of the Trans Patriot bus service performance has met the standards set by the Directorate General of Land Transportation.
2. Service performance improvement is carried out by fixing services that are not in accordance with service standards, such as intermediate time and frequency.
3. From the results of the cartesis diagram formed, there is something that needs to be done to improve the service level which is still below the expectations of the trans patriot bus service user, so that it matches the desired expectations at the service level located in quadrant III, such as: availability of safety facilities, availability of information that includes telephone numbers and text of complaints, according to the time of arrival and departure with the schedule, availability of information on the nearest trans patriot bus stop, the availability of a special room for passengers carrying wheelchairs and the availability of priority seats. Which must be fixed again to suit the wishes of the passengers.
4. The impact of covid-19 when new habits have increased from before Covid-19 on indicators such as: load factor, headway, travel time and travel speed.

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Analysis Tower Bts Sst 4 Leg Angular 42m Due To Extend and Additional Antenna Load (Case Study of The Semayap Kotabaru Location)

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Abstract

In BTS tower planning, the load that affects is the tower load itself, live load and lateral (side) loads that have a dominant effect is wind loads, because wind loads have high sensitivity to steel construction buildings (have a mass that tends to be light). Wind loads are calculated according to the Telecommunications Industry Association and Electronic Industries Alliance (TIA / EIA) standard structural standards for steel antenna tower and antenna supporting structure (TIA / EIA-222-G, 2005). The analysis uses the MS Tower V6 program, as an application to simplify telecommunication tower modeling. The purpose of this paper is to find alternative tower reinforcement so that it can withstand additional loads, be it additional loads due to extend and additional loads due to the proposed antenna.Based on the analysis results, the existing tower is still safe with a ratio of 0.345 <1, but the tower with an additional height and additional load of the antenna is not safe with a ratio of 1.189> 1, and the tower after being strengthened on the tower leg with a height of 0m-36m is done with STA (Star Angle) . And for reinforcement for leg towers at a height of 36-40m, it is done by adding the redundant member to the tower ratio to 0.689 <1, which means it is categorized as safe.Analysis with operational wind load (84km / hour), the reinforcement tower can withstand a maximum twist of 0.3436, a maximum sway of 0.0413, a maximum displacement of 0.1402.

Keywords
Analysis of Tower Structures, Extend Tower, MS Tower, Strengthening Tower, Tower BTS

1. Introduction

The development of telecommunication technology in Indonesia is increasing rapidly, even in the current Covid-19 pandemic, the telecommunications industry has not had much influence on its business. Telkomsel shows the accumulated percentage of their broadband service reached 16 percent during WFH due to Covid-19. The traffic surge was dominated by the growth of online learning application users such as Ruangguru, Ilmupedia Package, and Google Classroom, which increased by more than 5404 percent (CNNIndonesia.com).

Tower is a building structure that uses steel as the main material for construction, while BTS is part of the GSM network element associated with the Mobile Station. The construction of this BTS tower can be in the form of a tall tower or a short tower that has a lot of antenna power (often used for shared tower needs).

Figure 1. Self-Supporting Tower
Source: Data in research, 2019

1.1. Identification of problems

The main problem in this analysis is how to calculate the strengthening of the tower structure due to the addition of the structure and antenna load. The main parts of the tower structure are the main leg and bracing, so that the analysis of the profile capabilities of the two elements is the main thing. In the lateral load reinforcement planning that affects the domain is wind load, because the effect of the ratio of height and width of the structure is very large. Analysis study and design of height addition and tower reinforcement using the MS TOWER V6 program. From all analyzes, it is expected that the tolerance for additional loads can be known

1.2. Research Purpose and Objectives

The purpose of this study is to determine the strength of the existing tower (existing) by increasing the height to withstand the load to be added and as an effort to optimize the existing tower to increase profits.

1. Finding How much load is carried by the SST tower 4 Leg 42 extend 6 m.
2. Calculating the wind load acting on the gusset and antenna points.
3. Modifying the strengthening structure of the tower due to Extend tower and the increase in antenna load.
4. Creating a modeling design into the Ms Tower V.6 program.

2. Methodology

The research method used in this research is a survey method consisting of field data (existing) and literature studies. This type of case study research is research on the status of the object of research with respect to a specific phase of the whole person. The scope of this research can be in the form of a particular segment or part or an entire part of the object. Structural analysis in this paper uses the MS Tower v.6 program to analyze whether the structure is safe or not against the wind and to analyze whether the primary structure is strong or not withstand loads caused by the dead load of the structure and live loads and is assisted by Autocad software in the drawing results.

BTS tower structure planning is modeled with MS Tower software and is based on the following rules (code):

1. SNI 1729: 2015: Specifications for structural steel buildings.
2. TIA / EIA STANDARD-222-G-2005: Structural Standard for Steel Antenna Tower and Antenna Supporting Structures (Igustiany, 2011).
3. AISC-LRFD - American Institute of Steel Construction

Analysis and tower design requirements for the type of Self Suporting Tower are:

1. Stress Ratio Member < 1
2. Twist and Sway < 0.5°
3. Rotation arah X, Y and Z < 0.5°
4. Displacement < H/200 (H = Height Tower)

Wind Load on Tower Structure EIA/TIA 2006
Fst=qz.Gh.(EPA)s
Wind load on the antenna EIA/TIA 2006
F_a=K_z.V^2.Gh 〖(EPA)〗_A
Melt Withdrawal Gross Cross Section SNI 1729-2015
"Nu = ϕ (Ag x Fy)" ϕ = 0,90
Net Cross-sectional Failure SNI 1729-2015
"Nu = ϕ (Ae x Fu)" ϕ = 0,75
Nominal compressive strength requirements SNI 1729-2015
"ϕPn > Pu" ϕ = 0,85
Load Combination
1.2 D + 1.0 Dg + 1.6 Wo
0.9 D + 1.0 Dg + 1.6 Wo
1.2 D + 1.0 Dg + 1.0 Di + 1.0 Wi + 1.0 Ti

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3. Result and Analysis

A. In the initial planning, the tower used was the 42m tower data

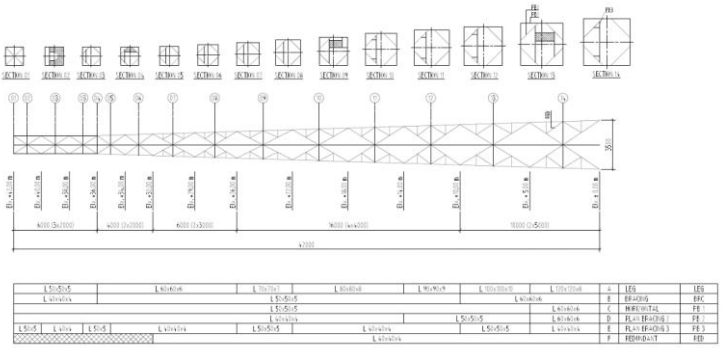

Figure 2. Outline Tower
Source: Data in research, 2020

In antenna load planning, the following specifications are used:

Table 1. Existing Antenna

No	Type	Height (m)	Weight (Kg)	QTY	Total (Kg)
	RF	39,5			
1	ATR4518R9		34	3	102
2	SH1PR-2	39,5	18,5	1	18,5
3	RRU 3959RU	38,5	14,4	6	86,4
4	RRU 3959RU	38	14,4	6	86,4

Source: Data in research, 2020

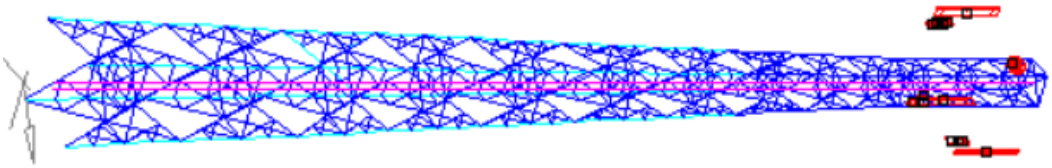

Figure 3. Modeling to MS Tower
Source: Data in research, 2020

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Analysis result of existing tower:

Table 2. Analysis result of existing tower

Description	Result		Design Limit	Remark
Operational Wind load (84 km/h)				
Twist (degree)	0,2524	<	0,5	Ok!
Sway (degree)	0,0176	<	0,5	Ok!
Displacement (m)	0,1039	<	0,21	Ok!
Rotation Antenna				
Max. rotation-X	0,2654	<	0,5	Ok!
Max. rotation. -Y	0,2638	<	0,5	Ok!
Max. rotation -Z	0,0177	<	0,5	Ok!
Wind Speed Plan (120 km/h)				
Max. Stress Ratio				
Leg	0,345	<	1	Ok!
Bracing	0,259	<	1	Ok!
Horizontal	0,034	<	1	Ok!
Plan Bracing	0,035	<	1	Ok!
Redundant	0,207	<	1	Ok!
Tower Weight	4340.67 kg			

Source: Data in research, 2020

B. Planning extend tower 42m +6 with the following data

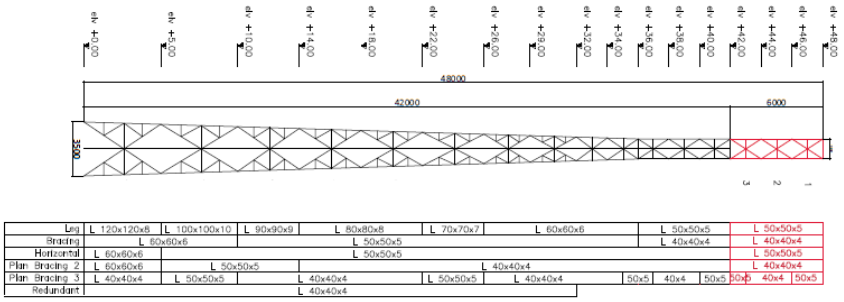

Figure 4. Modeling extend Tower
Source: Data in research, 2020

Load planning data used

Table 2. Existing & proposed antenna

No	Type	Height (m)	Weight (Kg)	Qty	Total (Kg)
1	RFATR4518R9	39,5	34	3	102
2	SH1PR-2	39,5	18,5	1	18,5
3	RRU 3959RU	38,5	14,4	6	86,4
4	RRU 3959RU	38	14,4	6	86,4
	RF				
5	ATR4518R9	47	34	3	102
6	RRU 3959RU	46,5	34	6	204
7	RRU 3959RU	46	14,4	3	43,2
8	SH1PR-2	47	18,5	1	18,5

Source: Data in research, 2020

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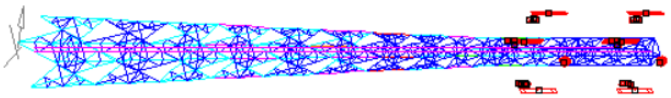

Figure 5. Modeling to MS Tower
Source: Data in research, 2020

Analysis result of extend tower:

Table 3. Analysis result of extend tower

Description	Result		Design Limit	Remark
Operational Wind load (84 km/jam)				
Twist (degree)	0,5645	>	0,5	Not Ok!
Sway (degree)	0,0406	<	0,5	Ok!
Displacement (m)	0,2419	>	0,24	Not Ok!
Rotation Antenna				
Max. rotation -X	0,5893	>	0,5	Not Ok!
Max. rotation -Y	0,5892	>	0,5	Not Ok!
Max. rotation -Z	0,0413	<	0,5	Ok!
Wind speed plan (120 km/jam)				
Max. Stress Ratio				
Leg	1,189	>	1	Not Ok!
Bracing	0,61	<	1	Ok!
Horizontal	0,095	<	1	Ok!
Plan Bracing	0,078	<	1	Ok!
Redundant	0,538	<	1	Ok!
Weight Tower			Kg	

C. Strengthening plan

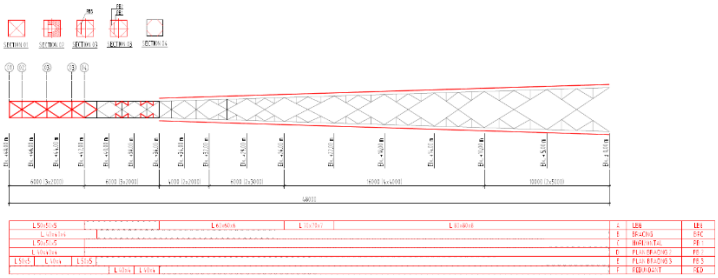

Figure 6. Modeling extend Tower
Source: Data in research, 2020

Table 4. Profile strengthening

Elevation	Profile Leg	Profile STA
+0.00 s/d +5.00	EA 120x120x8	EA 80x80x8
+5.00 s/d +10.00	EA 100x100x10	EA 80x80x8
+10.00 s/d +14.00	EA 90x90x9	EA 80x80x8
+14.00 s/d +22.00	EA 80x80x8	EA 80x80x8
+22.00 s/d +26.00	EA 70x70x7	EA 70x70x7

Source: Data in research, 2020

Strengthening with coupling plate

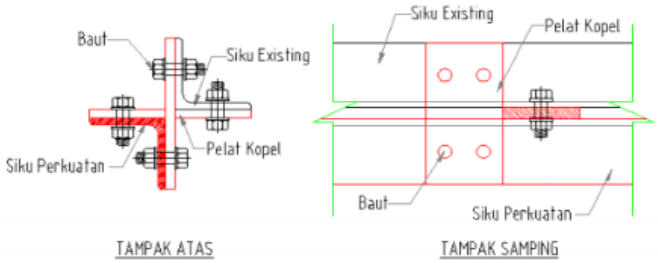

Figure 7. Modeling coupling plate
Source: Data in research, 2020

Analysis result of strengthening tower

Table 5. Analysis result of strengthening tower

Description	Result		Design Limit	Remark
Operational wind speed (84 km/jam)				
Twist (degree)	0,3436	<	0,5	Ok!
Sway (degree)	0,0413	<	0,5	Ok!
Displacement (m)	0,1402	<	0,24	Ok!
Rotation Antenna				
Max. rotation-X	0,3633	<	0,5	Ok!
Max. rotation-Y	0,3632	<	0,5	Ok!
Max. rotation-Z	0,0413	<	0,5	Ok!
Wind speed plan (120 km/jam)				
Max. Stress Ratio				
Leg	0,682	<	1	Ok!
Bracing	0,729	<	1	Ok!
Horizontal	0,137	<	1	Ok!
Plan Bracing	0,094	<	1	Ok!
Redundant	0,627	<	1	Ok!
Weight Tower	6049.19 kg			

Source: Data in research, 2020

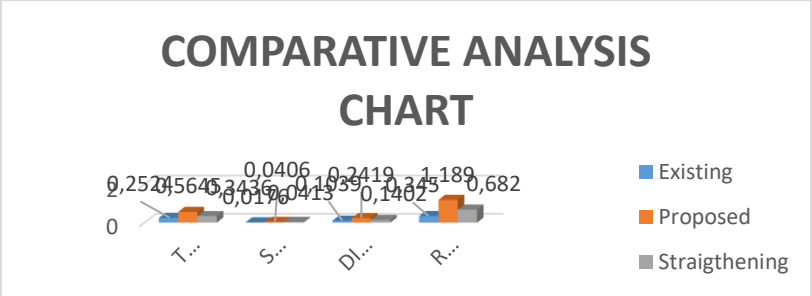

Figure 8. Comparative analysis chart
Source: Data in research, 2020

Check the analysis manual

Checking the slenderness of the cross section

λ=(ky .Ly)/iy= λ < 150 (TIA-222-G)

λ =(0.8 .1163)/15.2= 61.21 < 150 (ok)

Check the ratio to compression

Bending critical stress

Terms 1, where:

$$\lambda \leq 4.71\sqrt{\frac{E}{fy}} \quad or \quad \frac{fy}{Fe} \leq 2.25$$

bending elastic: $Fcr = (0.658^{\frac{fy}{Fe}})fy$

Terms 2, where:

$\lambda > 4.71\sqrt{\frac{E}{fy}}$ or $\frac{fy}{Fe} > 2.25$

bending inelastic : $Fcr = 0.877.fe$

Then,

$$4.71\sqrt{\frac{200000}{245}} = 134.57 \quad \text{So, } 61.21 \leq 134.57 \text{ including bending elastic}$$

Determine the value of Fcr

Based on the results of the above calculations, the formula for finding the value

$Fcr = (0.658^{\frac{fy}{Fe}})fy$

$Fe = \frac{\pi^2 . 200000}{61.21^2} = 526.30$

$Fcr = \left(0.658^{\frac{245}{427.89}}\right)245 = 201{,}63$

Determine the nominal compressive strength of the cross section

$Pn = Fcr . Ag$

$= 201.63 . 480.2$

$= 96821{,}23\ N = 96.82\ KN$

$\emptyset . Pn = 0.85 . 96.82 = 82.30\ KN$

Terms of press ratio

terms 1, $\emptyset . Pn \geq Pu$

$82.30 \geq 19$ OK!

terms 2, $\frac{Pu}{Pn} \leq 1$

$0.20 \leq 1$ OK!

Check rod for pull

$Pn = fy . Ag$

$= 245 . 480.2 = 117649\ N = 117.65\ KN$

$\emptyset t . Pn = 0.85 . 117.65 = 100.00\ KN$

Terms 1, $\emptyset t . Pn \geq Pu$

$100.00 \geq 18$ OK!

Terms 2, $\frac{Pu}{\emptyset t . Pn} \leq 1$

$0.18 \leq 1$ OK

4. Conclusion

After re-analyzing the structure of the 42 m tower with the addition of a height of 6m 4 feet, the following conclusions are obtained:

a. In the analysis of the tower after adding the load to the antenna, propose and extend the tower, it is found that the tower condition is not strong and requires reinforcement. With a capacity ratio ratio of 118.9% or 1.189> 1.
b. It is known that after the increase in the height and load of the antenna, the structural failure that experienced a structural failure was the leg of the tower at a height of 0m-40m. Strengthening the tower leg at a height of 0m-36m is reinforced with STA (Star Angle). And reinforcement for leg towers at a height of 36-40m is done by adding a redundant member.
c. After the reinforcement analysis is done, the results show that the tower condition is strong, with a capacity ratio of 68.2% or 0.682 <1.3.1.
d. Based on the analysis with operational wind loads (84km / hour), the reinforcement tower can withstand a maximum twist of 0.3436, a maximum sway of 0.0413, a maximum displacement of 0.1402.

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Analysis Comparison of Plate and Beam Formwork Using Semi Conventional Formwork with Aluminium Formwork System in Terms of Cost and Duration on Vasanta Innopark Project

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Abstract

The development of technology in the world of construction in Indonesia marked with the increasing number of innovations used in the construction process, one of which is formwork. Formwork is one of the most influential jobs on construction projects, especially in terms of cost and time. Therefore, modern Formwork innovations continue to emerge, one of which is Aluminium Formworks System. In this study the authors conducted comparative analysis of cost and time among semi-conventional Formwork with Aluminium Forcoand also spread questionnaires to find out if the Aluminium formworks are effective in replacing semi-conventional formworks on the Vasanta Innopark project. The results of the questionnaire will be analyzed using validity tests, realibility, correlation, and regression in SPSS software. The result of this research, the total cost needed for semi-conventional formwork is Rp. 6,577,699,867.20 and the total cost for the aluminium formwork is Rp. 6,985, 970.893.44 where aluminium formwork is more expensive by Rp 408,271,026.44 or 5.84% more expensive. And the time required conventional formwork is for 342 days while for aluminium formwork for 180 days or with a difference of 162 days or about 47.37 percent. And from the results of the questionnaire obtained that the effectiveness of aluminium formwork in replacing semi-conventional formwork is 0.833 or 83.3%.

Keywords
Aluminium Formworks System, Banging, Cost, Effectiveness, Kumkang, Semi Conventional Formwork, Time.

1. Preliminary

Along with the changing times of course we already know together that technology is growing in this digital age. The development of this technology could be an advantage or vice versa could be a boomerang due to resource unpreparedness. The development of technology in the world of construction in Indonesia is characterized by the increasing number of innovations used in the construction process, one of which is form of form. The cost for forming ranges from 40% - 60% of the cost of concrete work or about 10% of the total cost of building construction. Here it appears that there is a large process that is a form of form form that we have to review because so far using conventional systems there are many things that should be maximized in this process.

According to the book Gazali (2018), in 2016 some brand formisting is just starting to emerge. One of them is the use of aluminum form sheeting. The widespread use of aluminum formwork is a big step for the construction industry, but it does not increase efficiency just for the industry but also saves materials, money, labor and human resources time. With the good quality of the construction site, aluminum form sheeting will be increasingly used in future builds.

In Vasanta Innopark Project, PT PP (Persero) Tbk located in Jalan Kalimantan, Industrial Area, Cibitung, using Aluminum Formwork System (kumkang). As for the object of study for the title of My Final Task is a multi-storey building construction project.

2. Methodology

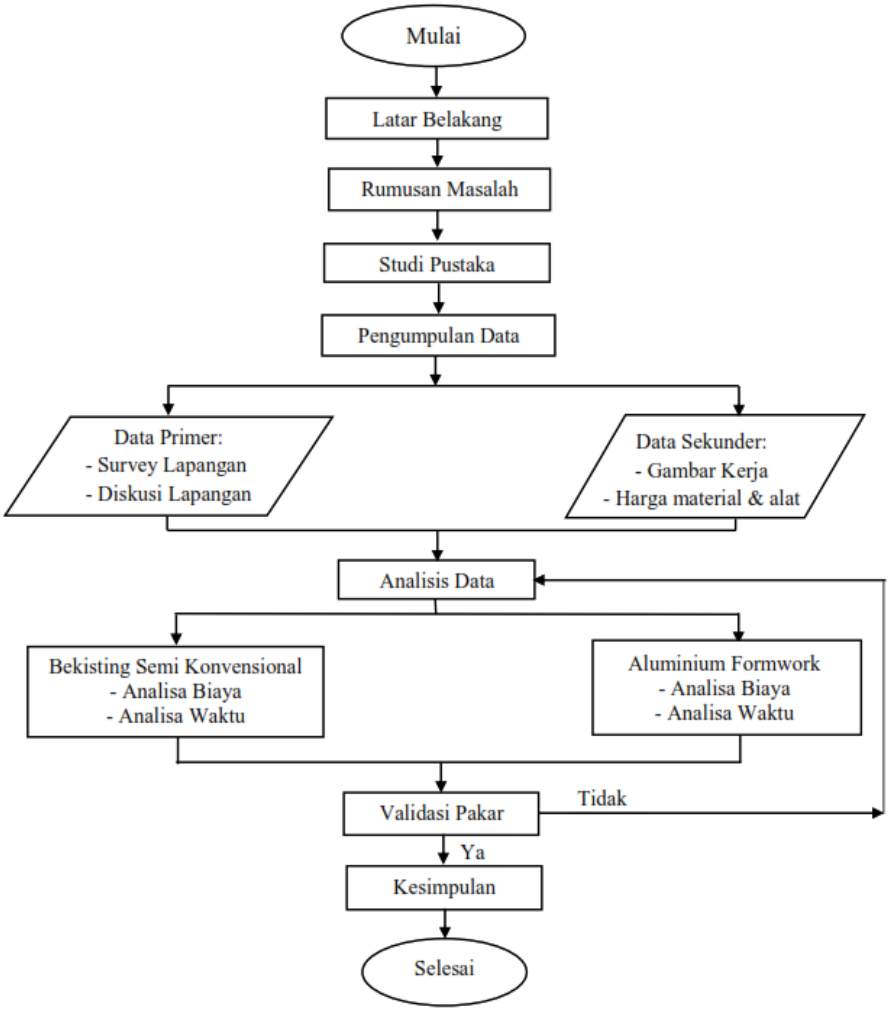

Figure 1. Methodology

According to Sugiyono (2017) variables are an attribute or trait of or value of a person, object or activity that has certain variations set by researchers to be studied and then drawn conclusions.

In determining variables, researchers reviewed the results of previous research journal literature studies and conducted interviews with project staff to obtain variable synchronization relevant to the conditions of the project reviewed. Furthermore, in order for variables to be easy to understand, researchers divide them into 7 important aspects.

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Table 1. Research Variable

No	Indikator	Sub Indikator
1	Material	X1. Delivery of materials
		X2. Material scarcity
		X3. Availibility of construction materials
		X4. Material resistance to field conditions (weather, impact, etc)
		X5. Quality of tools and materials
		X6. Material conditions in storage
2	Labour	X7. Number of manpower
		X8. Labour productivity
		X9. Knowledge and experience of the workers
		X10. Easeof field work supervision
		X11. Labour time discipline
		X12. Communication between labour and supervisory bodies
3	Social environment	X13. Durability in weather conditions (rain, etc.)
		X14. Field accidents
		X15. Impact of residual material on the surrounding environment
		X16. Job security in the field
		X17. Material waste disposal site
4	Execution time	X18. Owner accuracy in making decisions
		X19. Accuracy of sub-contracor schedule on completion
		X20. Added jobs
		X21. Accuracy of report creation and occupation administration
		X22. Accuracy of work in the installation of formwork
		X23. Tool life
		X24. Project schedule assignment by owner
		X25. Explanation of the work to be carried out
		X26. Ease moving tools and materials
		X27. Ease of installing formwork
		X28. Ease of access in working / neater in terms of appearance
		X29. Schedule planning
5	Design	X30. There is a design change by the owner
6	Financial	X31. Aaccuracy in allocating funds
		X32. Price of materials
		X33. Payments to workers
		X34. Late payment by owner
		X35. Delay in requesting payment submission by contractor
		X36. Rising prices and materials
7	Equipment	X37. Availability of work equipment
		X38. Equipment damage
		X39. Delivery of equipment
		X40. Equipment productivity
		X41. Number of items in each series
		X42. Completeness of worker tools
		X43. Lack of equipment operator availability

Source: Processed by Author, 2020

2.1 Questionnaire

Questionnaire is a data collection technique performed by giving a set of questions or written statements to the respondent to answer. This questionnaire was created to find out how effective the use of Aluminum form matter is in lieu of semi-conventional form form. In determining variables in the questionnaire, the authors conducted discussions and interviews with experts, experts in this study numbered 3 people, with the following expert criteria:

1. Work for a construction company.
2. Minimum bachelor's education
3. Minimum experience ≥ 10 years.

2.2 Data Analysis

Data collected in the field through questionnaires will be analyzed using statistical techniques as described below:

Cost Analysis

Cost Anaysis using Unit Price Method. In the unit price method the cost is analyzed based on per unit price, the estimated cost is done by multiplying the number of units of work known to the amount by the unit price. This method is very quick to use but it is very difficult to make accurate estimates because it is difficult to make adjustments to the unit price in the event of a change in the size, shape and quality of the construction type. However, because in the Vasanta Innopark project there is no change or change of panel size, so this method can be used for this research.

Time Analysis

To calculate the time analysis, it is used using the productivity target formula, namely:

$$P = \frac{V}{T\ x\ n}$$

Where:

P : Labor productivity is the amount of work that a workforce can complete every day.

V : Job Quantity

n : Number of workers used

T : Duration of Work

Validity Test

The data validity test was performed using the SPSS software tool using Corrected Item Total Correlation number (r) results through the Scale menu in the Reliability Analysis option. This analysis is done by correlating each item's score with the total score. Testing using two-party test with a significance level of 0.05.

Reliability Test

Reliability analysis points to a sense that an instrument is trustworthy enough to be used as a data collection tool. A commonly used reliability analysis is cornbach alpha analysis. As for testing using cornbach alpha coefficient ≥ 0.6 which is a value that is considered to be able to test the validity of the questionnaire used with the aim of knowing the level of data reability generated by an instrument.

Correlation Test

Pearson correlation is one of the correlation measures used to measure the fund strength of the linear relationship rah of two variables. Two variables are said to correlate when one variable changes accompanied by another variable change.

Regression Test

A simple linear regression test analysis is a linear relationship between one independent variable and a dependent variable. This analysis is to find out the direction of the relationship between independent variables and dependent variables whether positive or negative.

3. Results And Analysis

3.1. Cost Analysis Result

Picture 2 shows that the cost of floor plate and beam form work using semi-conventional form work costs Rp. 3,917,502,468.00 for floor plates and Rp. 2,660,197,399.00 for beams. While using aluminum form matter requires a fee of Rp. 4,160,657,793.60 for floor plates and Rp. 2,825,313,099.84 for blocks. The difference between the two methods is Rp. 243,155,325.60 for floor plate work and Rp. 165,115,700.64 for beam work.

Here it can be seen that using aluminum form sheeting costs more than using semi-conventional formwork.

Figure 2. Cost Comparison
Source : Processed by Author, 2020

3.2 Result Time Analysis

Table 1. Time Comparison

No	Method	Duration
1	Semi Konventional	342 days
2	Aluminium Formwork	180 days
	DIFFERENCE	162 days

Source : Processed by Author, 2020

In table 1 it can be seen that using a semi-conventional formwork method takes 342 days to work for 36 floors while using aluminum form sheeting takes 180 days.

Both formwork methods have a difference of 162 jobs or use aluminum form sheeting faster than 162 days compared to semi-conventional formwork

3.3 Validity Test Result

Table 2. Validity Test Result

No	Code	r table	r hitung (Pearson Correlation)	Description
1	X1	0.312	0.48	Valid
2	X2	0.312	0.424	Valid
3	X3	0.312	0.396	Valid
4	X4	0.312	0.343	Valid
5	X5	0.312	0.455	Valid
6	X6	0.312	0.355	Valid
7	X7	0.312	0.443	Valid
8	X8	0.312	0.477	Valid
9	X9	0.312	0.397	Valid
10	X10	0.312	0.462	Valid
11	X11	0.312	0.366	Valid
12	X12	0.312	0.244	Invalid
13	X13	0.312	0.432	Valid
14	X14	0.312	0.337	Valid
15	X15	0.312	0.517	Valid
16	X16	0.312	0.342	Valid
17	X17	0.312	0.41	Valid
18	X18	0.312	0.375	Valid
19	X19	0.312	0.084	Invalid
20	X20	0.312	0.259	Invalid
21	X21	0.312	0.1	Invalid
22	X22	0.312	0.497	Valid
23	X23	0.312	0.513	Valid
24	X24	0.312	0.381	Valid
25	X25	0.312	0.383	Valid
26	X26	0.312	0.48	Valid
27	X27	0.312	0.411	Valid
28	X28	0.312	0.433	Valid
29	X29	0.312	0.17	Invalid
30	X30	0.312	0.435	Valid
31	X31	0.312	0.473	Valid
32	X32	0.312	0.35	Valid
33	X33	0.312	0.499	Valid
34	X34	0.312	0.155	Invalid
35	X35	0.312	0.083	Invalid
36	X36	0.312	0.455	Valid
37	X37	0.312	0.42	Valid
38	X38	0.312	0.441	Valid
39	X39	0.312	0.355	Valid
40	X40	0.312	0.502	Valid
41	X41	0.312	0.451	Valid
42	X42	0.312	0.345	Valid
1	Y	0.312	0.97	Valid

5. Source : Processed output SPSS

From table 2 it can be seen that there are 7 invalid free variables (X) due to the r count <r table, so there are only 35 free variables (X) and 1 bound variable (Y) that are declared valid.

3.4 Reliability Test Results

Table 3. Reliability Statistics

Reability Statistic	
Cronbach's Alpha	N of Items
0.884	36

Source : Processed Output SPSS

Cronbach's Alpha value for the 36 variables tested was 0.884 which means it fell into the Reliabel category due to the 0.884>r table (0.312).

3.5 Correlation Test Results

Table 4. Correlation Results

No	Code	Pearson Correlation	Sig. (2-tailed)	Description
1	X1	0.397	0.011	CORRELATION
2	X2	0.395	0.012	CORRELATION
3	X3	0.402	0.01	CORRELATION
4	X4	0.347	0.028	CORRELATION
5	X5	0.472	0.002	CORRELATION
6	X6	0.358	0.023	CORRELATION
7	X7	0.398	0.011	CORRELATION
8	X8	0.445	0.004	CORRELATION
9	X9	0.348	0.028	CORRELATION
10	X10	0.497	0.001	CORRELATION
11	X11	0.311	0.051	NOT CORRELATION
12	X13	0.418	0.007	CORRELATION
13	X14	0.253	0.115	NOT CORRELATION
14	X15	0.57	0	CORRELATION
15	X16	0.376	0.017	CORRELATION
16	X17	0.312	0.05	NOT CORRELATION
17	X18	0.34	0.032	CORRELATION
18	X22	0.467	0.002	CORRELATION
19	X23	0.542	0	CORRELATION
20	X24	0.399	0.011	CORRELATION
21	X25	0.319	0.045	CORRELATION
22	X26	0.491	0.001	CORRELATION
23	X27	0.482	0.002	CORRELATION
24	X28	0.462	0.003	CORRELATION
25	X30	0.384	0.015	CORRELATION
26	X31	0.428	0.006	CORRELATION
27	X32	0.317	0.046	CORRELATION
28	X33	0.51	0.001	CORRELATION
29	X36	0.349	0.027	CORRELATION
30	X37	0.382	0.015	CORRELATION
31	X38	0.472	0.002	CORRELATION
32	X39	0.386	0.014	CORRELATION
33	X40	0.438	0.005	CORRELATION
34	X41	0.471	0.002	CORRELATION
35	X42	0.351	0.026	CORRELATION

Source : Processed Output SPSS

From table 4 results it can be seen that there are 33 free variables (X) that correlate with bound variables (Y) because they have a value of <0.05" significance.

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3.6 Regression Test Result

Table 5. Coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Coefficients	t	Sig.
		B	Std. Error	Beta		
8	(Constant)	-2.343	0.535		-4.378	0.000
	X27	0.499	0.067	0.544	7.397	0.000
	X31	0.192	0.082	0.184	2.351	0.025
	X5	0.262	0.065	0.317	4.033	0.000
	X1	0.364	0.075	0.367	4.837	0.000
	X39	0.263	0.065	0.293	4.038	0.000
	X38	0.231	0.103	0.177	2.249	0.031
a. Dependent Variable: Y						

Source : Processed Output SPSS

Table 6. Table R Square

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.913[h]	0.833	0.802	0.370
a. Predictors: (Constant), X27, X31, X5, X1, X39, X38				

4. Conclusion

1. a. The implementation fee required for semi conventional form form form method is Rp. 6,577,699,867.20 while if using aluminum formisting amounting to Rp. 6,985,970,893.44. That means using Aluminum formwork costs more, but contractors are considering faster execution times and smaller rework because less structural repairs are required if using aluminum formwork.

b. Based on the data of the implementation time that has been done analysis, the duration of time required for semi conventional form of form is 342 days. While if using aluminum form matter is 180 days. Which means using Aluminum form matter takes less time compared to semi-conventional formwork.

2. a. Percentage difference in cost of both formisting methods is 5.84% or with a difference of Rp. 408,271,026.44. Can be seen in the table below:

Table 7. Table Percentage in cost

Works Item	Unit	VOLUME	CONVENSIONAL		ALUMINIUM FORMWORK	
			Unit Cost	Total	Unit Cost	Total
Floor Plate	m2	24561.144	159,500.00	3,917,502,468.00	169,400.00	4,160,657,793.60
Beam	m2	16678.3536	159,500.00	2,660,197,399.20	169,400.00	2,825,313,099.84
Total				**6,577,699,867.20**		**6,985,970,893.44**
Difference						**408,271,026.24**
Percentage Difference						**5.84%**

b. The percentage of time difference between the two methods of form form is 47.37% or with a difference of 162 days. Can be seen in the table below:

Table 8. Table Percentage of time

Works Item	Floor Total	Volume	Duration (day)	
			Semi Konventional	Aluminium Formwork
Floot Plate and beam	36	1145 m2	342	180
Difference				**162 days**
Percentage Difference				**47.37%**

3. Based on the analysis and discussion that has been presented in the previous chapter obtained a value of R Square of 0.833 or 83.3%. This figure shows that the effectiveness of aluminum formisting in replacing semi-conventional form sheeting is 83.3%.

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The Effect of Limestone Substitution as Cement and Plastic Waste Slike Aggregate Slike on the Compressive Strength of Concrete

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ABSTRACT

With the development of concrete technology in these days, concrete innovation is needed because it does not rule out the possibility of this concrete material, namely fine aggregate, coarse aggregate, cement, and water, which is decreasing over time or thinning. An innovation is needed that can reduce the use of cement by using other materials, so that the amount of cement usage can be reduced. Examples of innovation as a material that can be mixed with concrete include fly ash, palm ash, extinguished lime, bagasse ash and others. This is what drives research for concrete mixtures other than sand, gravel, cement and water, adding materials to the concrete mixture, namely limestone as a substitute for cement and plastic waste as a substitute for coarse aggregate. The use of limestone is expected to reduce cement levels and the use of plastic waste can reduce the use of gravel from river stones so as not to damage the river ecosystem. The addition of limestone and plastic waste is expected without reducing the strength of the concrete. This study uses the percentage of limestone made with a percentage variation from 0% to 15% (0%, 1%, 5%, 10%, and 15%) of the volume of cement based on experiments (mix design calculations) and for plastic waste with a percentage variations from 0% to 10% (0%, 1%, 5%, and 10%) of the crude aggregate volume based on my experiment (mix design calculations). The concrete is molded by using 4 cylindrical molds measuring 15cmx30cm for each test concrete quality. The compressive strength will be tested at the age of 14 and 28 days. The results of the research on concrete with additional substitution in the form of lime which was substituted into cement and plastic waste substituted for crude in coarse agrrates tended to experience a decrease in quality or compressive strength when compared to normal concrete without any added substitute materials. Research on the highest compressive strength value of concrete mixed with substitution material is the mixture or variation A (1% + 1%) with the average results of 20.27Mpa.

Keywords
Compressive Strength.. Concrete, Innovation, Limestone, Plastic Waste, Substitution.

1. Introduction

In the field of construction continues to develop technology not only in Indonesia but in various other countries also experienced very rapid development. Almost all buildings are designed using strong concrete quality, durable or durable and efficiency. Of the many buildings, almost all use concrete base materials ranging from foundations, columns, beams, plates, drainage grooves, and architectural combinations. Concrete is one of the most popular construction materials used since hundreds of years ago. Concrete is chosen because it has many advantages over other materials. Concrete is a mixture of portland cement aggregates (fine aggregates and coarse aggregates) of water and is sometimes coupled with the use of varied additional materials ranging from chemical surcharges, fibers to non-chemical building materials at a certain comparison. (Tjokrodimuljo, 2007), But as technology evolves in this day and age, concrete innovation is necessary because it does not close the possibility of concrete material i.e. fine aggregate / sand, rough aggregate / gravel, cement, and water the longer it decreases or thins. It needs innovation that can reduce the use of cement by using other materials, so that the use of cement can be reduced in number. Examples of innovations as materials that can be dried and concrete include fly ash,palm ash, lime extinguished, cane ampas ash and others..This is the driving force for concrete mixture in addition to fine aggregate/ sand, rough aggregate / gravel, cement and water is done the addition of materials in concrete mixture i.e. limestone as substitution to cement and plastic waste as substitution of coarse aggregate / gravel. The use of limestone is expected to

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reduce cement levels and the use of plastic waste can suppress the use of gravel from stone times as it does not damage river ecositems. The addition of limestone and plastic waste is expected without reducing the strength of the concrete.

2. Research Materials And Methods

2.1 Materials

a. Semen used for this research in the form of portland cement type I gresikbrand.
b. Afine gregat or sand used for this research is lampung sand.
c. A rough gregat used for this study in the form of gravelresulting from the disintegration of rocks or in the form of broken stones resulting from manual solving or using a breaking machine derived from bogor. .
d. The water used in this study came from the UMB Civil Engineering Laboratotium.
e. The limestone used is obtained from Kelapa Nunggal limestone mining, Bogor Regency.
f. The plastic waste used is obtained from the wreckage of a shell.

2.2 Research Methods

The type of research used is by meode experiments, using additional materials against concrete, additional materials in the form of limestone as subtitution to cement and plastic waste as subtitution to rough aggregates, for this study to obtain data and results conducted testing in the laboratory.Experimental research methods are methods used to look for the influence of certain treatments on others in controlled conditions (Sugiyono, 2009). This research uses mix-design so that fine aggregate values, rough agrega, cement, limestone and plastic waste, can be known from the MS-Excel calculation process.Before conducting this mix-design research materials that will be in concrete making are carried out checks on fine aggregate materials, and rough aggressors, in order to know the karakeristic of each aggregate. After the aggregate inspection stage, the next stage is mix-design. Continue the stage of mixing limestone and plastic waste dangan varying values as a substitute for cement and a replacement of the coarse aggregates used in the concrete mixture. After all the process was completed do the manufacture of concrete test objects and continued with strong testing of concrete press.

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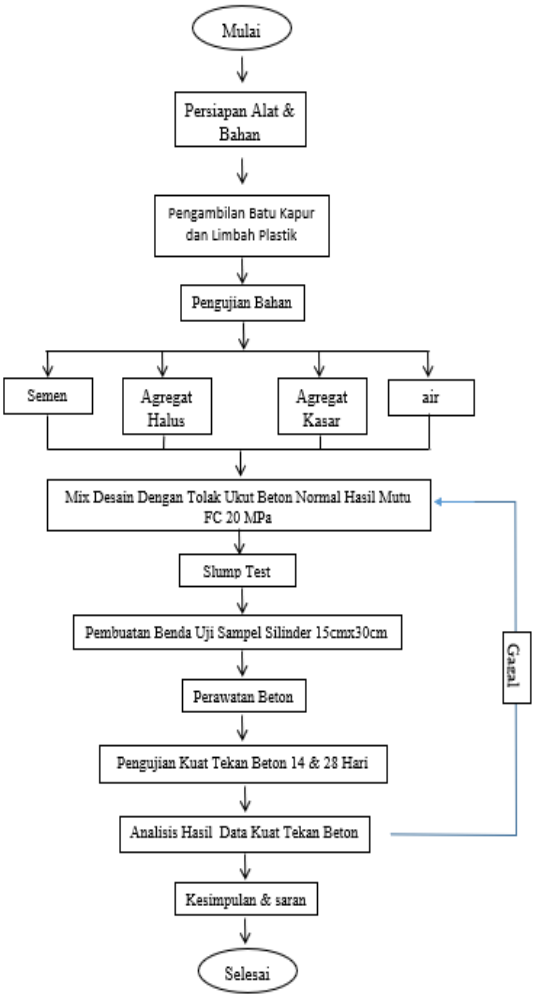

Figure 1 Of the Research FlowchartFlowchart)
Source: Research Data Penelitian

Table 1. Material requirements for 1 concrete withm ^ 3FC-20 MPa quality concrete with FC quality

Materials	**Needs (kg/m^3)**
Cement	427,083
Water	205
Sand	491,53
Gravel	1264,38

The research was conducted as many as 12 variations of the mixture plus normal concrete as control concrete. Each variation per day there are 2 samples for testing. So, the total of all variations plus normal concrete as much as 52 samples. Here is the number of material needs for each cylinder 15x30 cm:

Table 2. Material needs for 1 cylinder 15x30 cm

Presentase Variasi		Semen	Kerikil	Pasir	Air	Batu Kapur	Limbah Plastik
Batu Kapur (Semen)	Limba Plastik (Kerikil)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
0%	0%	2,27	8,04	3,13	1,30	0	0
1%	1%	2,693	7,7970	3,13	1,30	0,0272	0,0804
5%	5%	2,136	7,799	3,13	1,30	0,136	0,402
10%	10%	2,448	7,638	3,13	1,30	0,272	0,804
15%		2,312		3,13	1,30	0,408	
Jumlah		12,309	31,1618	15,65	6,5	0,8432	1,2864

2.2 Research Place and Time

Venue: Laboratotium Structure and Materials
Building Civil Engineering Study Program, Faculty of Engineering, Mercu Buana University Bekasi Campus D.
When : September 2019 to January 2020

3. Results And Discussions

Analysis of the gradation of kapur stone is necessary to know the size of the granules tobe used as a mixture in the test concrete research, limestone is used as a cement substitution material.

Table 3. Limestone gradation gradation testing

Saringan	Berat Tertahan (gram)	Jumlah Berat Tertahan (gram)	Jumlah Persen	
			Tertahan	Lewat
50.80 (2")				
25.40 (1")				
19.10 (3/4")				
6.3 (1/4")	-	-	0.00	100.00
No. 4	0	0.00	0.00	100.00
No. 8	0.00	0.00	0.00	100.00
No. 12	10.00	10.00	1.00	99.00
No. 20	30.00	40.00	4.00	96.00
No. 40	30.00	70.00	7.00	93.00
No. 80	70.00	140.00	14.00	86.00
No. 100	210.00	350.00	35.00	65.00
No. 200	140.0	490.00	49.00	51.00
PAN	10.0	500.0	50.00	50.00

Source: Research Data Penelitian

Analysis of plastic waste gradation is necessary to determine the size of the granules tobe used as a mixture in the test concrete research,usedas a rough aggregate substitution material, granules usedequal to a maximum grained rough aggregate of 4.75 cm, or filter no. 4.

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Table 4. Plastic waste gradation gradation testing

Saringan	Berat Tertahan (gram)	Jumlah Berat Tertahan (gram)	Jumlah Persen	
			Tertahan	Lewat
50.80 (2")	0	0		
36.10 (1 1/2")	0	0		100.00
25.40 (1")	0	0	0.00	100.00
19.10 (3/4")	380	380	38.00	62.00
6.3 (1/4")	350	730	73.00	27.00
No. 4	270	1000	100.00	0.00
No. 8	0	1000	100.00	-
No. 12	0	1000	100.00	-
No. 16	0	1000	100.00	-
No. 30	0	1000	100.00	-
No. 50	0	1000	100.00	-
No. 100	0	1000	100.00	-
No. 200	0	1000	100.00	-
PAN	0	1000	100.00	0.00

Sumner : Research Data

3.1 Slump Testing (Workability)

Testing of slump (workability)is necessary to know the level of fresh concrete kelecakan. The higher the slump value, the more diluted the concrete and easier to work with, and vice versa. In this study, researchers planned a slump value of 6-18 cm.

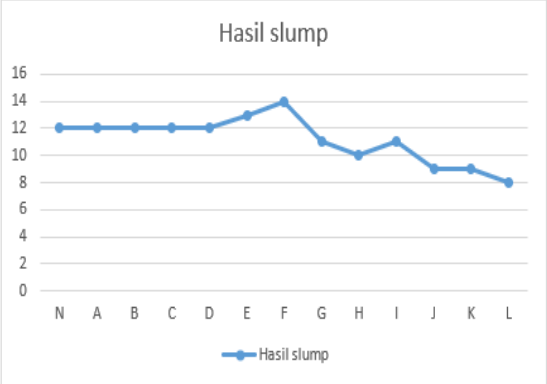

Figure 2. Value of Slump Test Results
Source: Research Data

From the data of the above test results, it can be seen that in this study the more the amount of limestone and plastic waste mixed then the lower the slump value. This can be seen from the graph of the result of the slump that is decreasing.

3.2 Strong Concrete Press Testing

Strong press testing of test objects is performed using 4 samples per variation.. Denag every test 2 samples per day 14, and 2 samples perday28. Here are the results of the powerful test press:

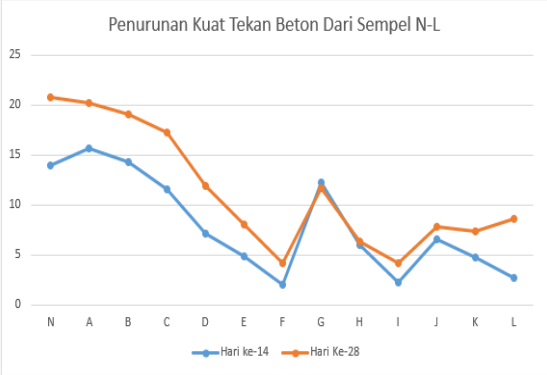

Figure 3 Results of Strong Concrete Press
Source: Research Data Penelitian

Based on the results of the study the highest press strong value of concrete mixed with substitution material is in the mixture or variation A (1% + 1%) with an average yield of 20.27Mpa. Based on the results of concrete extraction mixed with the substitution material of limestone additional material and plastic waste the highest slump value is found in variation C (5 % + 1%) 14 cm, and the lowest slump value is found in the L variation (15 % + 10 %) namely 8 cm, where the result is still in accordance with the calculation of the design mix which is between 80 - 150 mm.

4. Conclusion

Based on didapat limbah the results campuran of testing and analysis on the influence of lime extinguished as cement subtitution material and plastic waste as a rough aggregate subtitution material on concrete mixture against strong concrete press, obtained conclusions as follows:

1. Based on the results of concrete research with additional substitutions in the form of chalk substitused into cement and plastic waste substituted keladalam agrgat rough tends to experience a decrease in quality or strong press when compared to normal concrete in the absence of substitution added material. The larger the mixture of lime bartu and plastic waste in the concrete mixture, the lower the slump value obtained, this is because the weight of the type of lime smaller than cement makes more mixture in the form of limestone making the more water absorption that occurs resulting in bitterness.
2. Based on the results of the study the highest press strong value of concrete mixed with substitution material is in the mixture or variation A (1% + 1%) with an average yield of 20.27Mpa.
3. Based on the results of concrete extraction mixed with the substitution material of limestone additional material and plastic waste the highest slump value is found in variation C (5 % + 1%) 14 cm, and the lowest slump value is found in the L variation (15 % + 10 %) namely 8 cm, where the result is still in accordance with the calculation of the design mix which is between 80 - 150 mm.
4. Based on the results of concrete research with substitution material in the form of chalk as cement substitution material and plastic waste as a substitution material of rough aggregate with substitution variation C can be used in the construction of structures because it has strong results press 28 days still in accordance with the initial planning and for other variations more efficiently used for the manufacture of non-structural concrete.
5. In this study, the effect of plastic waste on concrete mixtures did not experience chemical elements that caused a decrease in the strong press of concrete, but only due to negligence in the manufacture of test objects or commonly referred to as technical problems.

4.1 Suggestion

Based on the results of observations and research, the advice that can be taken from this research, namely as follows:

1. At the time of the research, there needs to be a special thoroughness to the testing of materials materials, testing of additional materials, calculation ofe mix design, curing control, and strong test press, in order to get the maximum results.
2. At the time of the manufacture of test materials that need to be considered a good and homogeneous concrete stirring process, which is then followed by compaction on the mold is done carefully so that the resulting concrete does not suffer damage to the concrete, in the event of a damage to the concrete will affect the result of the strong value of the concrete press.

3. In further research, it is recommended to burn limestone first to rejuvenate the manual refining process, and for plastic waste the melting process is recommended to use open because when done melting resulting in air pollution and poorly obtained results or fragile cenderukng.

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Acid Effect Sulphate Against Strong Concrete Press Containing Lime As Substitutions of Cement and Glass As Substitution of Coarse Aggregate

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Abstract

Lime as a concrete mixture is done because lime contains elements of calcium oxide (CaO) which is the material for the manufacture of cement from 60-65% (Tjokrodimuljo, 2007). Glass waste comes from the waste glass industry has a silica content of 72.20% (Fikriansyah and Tanzil, 2013). The use of these two materials as a concrete mixture of substitution material is expected to reduce the pollution of the CO2 gas environment due to the burning of steam from the manufacture of cement and natural resources exploitation due to excessive aggregate mining. This research aims to determine the influence of sulphuric acid from 2% for strong concrete emphasis that contains glass in lieu of coarse aggregate and lime as a cement substitution. Penelitian ini menggunakan campuran lime dari 7% dan 10% dari berat semen, serta 5% dari limbah glass, dan 9% dari berat kerikil. Compressive strength testing is carried out on the 7th, 14th, 21th, and 28th days. Results of this study showed that the strong emphasis of concrete with a lime mixture of 10% + 5% Glass on 28 days obtained a strong press of 12.13 MPA higher than normal concrete ie 7.68 MPA on the 28th day.

Keywords
Compressive Strength, Concrete, Environmentally Friendly Materials, Waste Glass

1. Introduction

Concrete is a building material that is strong against the pressure, but strong concrete press can be decreased which can be caused by external problems or environmental problems, such as for example such as the environment of acidic rain area industrial areas Cibinong – Citeureup Bogor. Basuki (2013)said that this concrete chemical attack is practically distinguished by five categories, Namely categories of acids, ammonium, magnesium, sulphate and alkali hydroxide. The attack of sulfuric acid in concrete can cause damage to the long term in the structure of buildings, especially building structures such as foundations, and basement.

Departemen Pekerjaan Umum (1991) provides a definition of concrete as a mixture of Portland cement or other hydraulic cement, smooth aggregate, coarse aggregate and water, with or without additional material forming solid mass. The negative impact of cement mill gas disposal is CO2, annually over 4 billion tonnes of cement in production and contributes as much as 8% carbon dioxide emissions (CO2) in the world (Lehne and Preston, 2018). As a result of the increasing impact of CO2 it will result in the effect of global warming or greenhouse effect causing the temperature on the Earth's surface to rise.

In addition to cement, concrete manufacturing materials are gravel and sand. To get it must be done mining that can pollute the environment, the impact that will occur when conducting continuous mining of landslides, lack of water availability, erosion.

In this research will try to substitute the waste of glass with gravel, and substituted lime with cement and then soaked in sulfuric acid water. The glass also contains silica of 72.20% (Fikriansyah and Tanzil, 2013) which can be used as a substitute for concrete mixture. The selection of lime as a concrete mixture is done because lime contains elements of calcium oxide (CaO) which is a material for the manufacture of cement of 60-65%, (Tjokrodimuljo, 2007).

2. Materials and Methods

2.1. Materials

In this research the materials used in concrete mixtures are as follows:

a. The lime used in this study is the lime-calcium powder breaching found in the building store
b. Glass used is a type of tempered glass from the company PT. Aneka Kreasi Glassindo, Cawang, Jakarta timur

c. Sulfuric acid used in the study is a liquid sulphuric acid that can be obtained in the chemical store
d. Cement used in this research is type 1-OPC cement from Gresik cement
e. The water used in this study came from the UMB civil Engineering Laboratotium.
f. The sand used in this study was the sand that originated in Bangka.
g. The gravel used in this study was gravel derived from Bogor.

Figure 1. Lime Calcium

Figure 2. Tempered Glass

2.2. Methode

In this research researchers use experimental methods by mixing free variables and and in the underlying. The free variables in this study were lime (X1) and glass waste (X2), while the company's variables were sulfuric (Y) and strong concrete press [Z]. Both variables are mixed in one concrete mixture with a variation of 7% and 10% of the weight of cement for the variation of lime, 5% and 9% of the weight of gravel for variations of glass waste and then soaked with acid sulfate liquid by 2%

Before conducting the test, there are several necessary steps that prepare the necessary tools and materials. After that the material is tested according to testing standards. If the materials used meet the requirements, the next stage is the calculation of mix design. After the mix design calculation is complete, the next step is to do a trial mix. At trial mix stage required slump test to know the fresh concrete workability. When the slump test is qualified, the concrete can be poured to the mold and wait until dry or ± 24 new hours the mold can be opened. In this research the concrete was printed using a cube mold measuring 15x15x15 cm. The next stage is the curing process at this stage of curing using acid sulphate liquid by 2% by soaking in the water bath until a specified day. The day before a strong test press, the concrete should be removed from the tub and drained first. Powerful test press done on day 7, to 21, to 24 and to 28 life of concrete. After the entire testing phase, the last stage is to analyze and conclude the result of the test.

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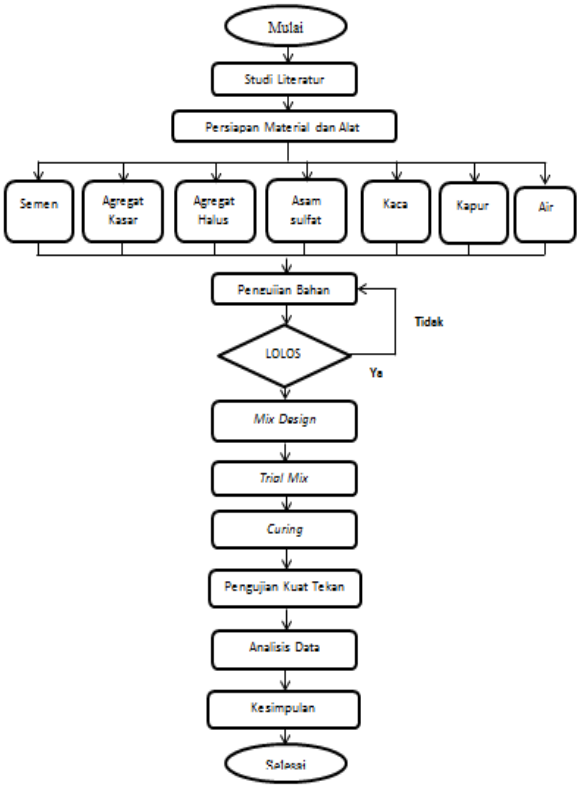

Figure 3. Flowchart

Table 1. Amount of Material Required For 1 m^3 Concrete With Quality K-175

Material	Amount of material (kg/m^3)
Cement	75
Water	45
Sand	172
Gravel	258

This research carried out as many as 4 variations of the mixture plus normal concrete as control concrete. Each variation of each day has 3 samples. So, the total of all variations plus normal concrete as much as 60 samples. Here is the amount of material needed for each 15x15x15 cm cube:

Table 2. Amount of Material Required For 1 Mold Cube 15x15x15 Cm

variation		cement	sand	gravel	water	glass	lime
glass	lime	(Kg)	(Kg)	(Kg)	(Kg)	(Kg)	(Kg)
0%	0%	1,2488	2,8620	4,2930	0,7493	0,0000	0,0
5%	7%	1,1613	2,8620	4,0784	0,7493	0,2147	0,087
9%	7%	1,1613	2,8620	3,9066	0,7493	0,3864	0,087
5%	10%	1,1239	2,8620	4,0784	0,7493	0,2147	0,125
9%	10%	1,1239	2,8620	3,9066	0,7493	0,3864	0,125

2.3. Place and Time of Research

a. place : Laboratotium Structure and Materials Building of Civil Engineering study Program, Faculty of Engineering, University of MERCU Buana Bekasi campus D.
b. Time : may 2020 s.d July 2020

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3. Results and Discussion

3.1. Gravel Gradation Testing

Figure 4. Gravel
Source : Research Data

Gravel gradation Testing aims to determine the gradation of gravel grains. Please note that gravel grains are held in the No. 4 sieve. Here are the results of gravel gradation testing:

Table 3. Gravel Gradation Testing

Heavy dry material : 1000 gr

Filter	Heavy restrained (gram)	Amount of weight held (gram)	amount percent	
			Stuck	Escape
50.80 (2")	0	0		
36.10 (1 1/2")	0	0		100,00
25.40 (1")	0	0	0,00	100,00
19.10 (3/4")	440	440	44,00	56,00
6.3 (1/4")	370	810	81,00	19,00
No. 4	190	1000	100,00	0,00
No. 8	0	1000	100,00	-
No. 12	0	1000	100,00	-
No. 16	0	1000	100,00	-
No. 30	0	1000	100,00	-
No. 50	0	1000	100,00	-
No. 100	0	1000	100,00	-
No. 200	0	1000	100,00	-
PAN	0	1000	100,00	0,00

Fineness Modulus = 7,25

Source : Research Data

3.2. Sand Gradation Testing

Figure 5. Sand
Source : Research Data

Sand gradation Testing aims to determine the gradation of sand grains. Please note that the grain of sand escapes in the sieve No. 100. Here are the results of sand gradation testing:

Table 4. Pengujian gradasi agregat halus

	heavy dry material :		1000,0	gr
filter	Heavey restrained (gram)	Amount of weight held (gram)	amount percent	
			stuck	escape
50.80 (2")				
25.40 (1")				
19.10 (3/4")				
6.3 (1/4")	-	-	0,00	100,00
No. 4	10	10,00	1,00	99,00
No. 8	30,00	40,00	4,00	96,00
No. 12	45,00	85,00	8,50	91,50
No. 16	55,00	140,00	14,00	86,00
No. 30	255,00	395,00	39,50	60,50
No. 50	350,00	745,00	74,50	25,50
No. 80	220,00	965,00	96,50	3,50
No. 100	20,00	985,00	98,50	1,50
No. 200	15,0	1000,00	100,00	0,00
PAN	0,0	1000,0	100,00	0,00
Fineness Modulus =	3,365			

3.3. Test Slump (Workability)

Slump test is needed to find out the level of fresh concrete agility. The higher the value of slump then the concrete is more dilute and easy to work, likewise vice versa. In this research researchers plan a slump value of 60-180 mm

Table 5. Test Stump

	Variation	Slump value
N	lime (0%) + Glass (0%)	11,3
A	Lime (7%) + Glass (5%)	10,4
B	Lime (7%) + Glass (9%)	9,8
C	Lime (10%) + Glass (5%)	11,3
D	Lime (10%) + Glass (9%)	10

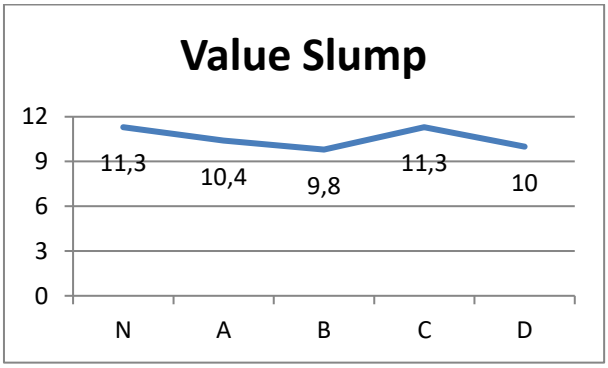
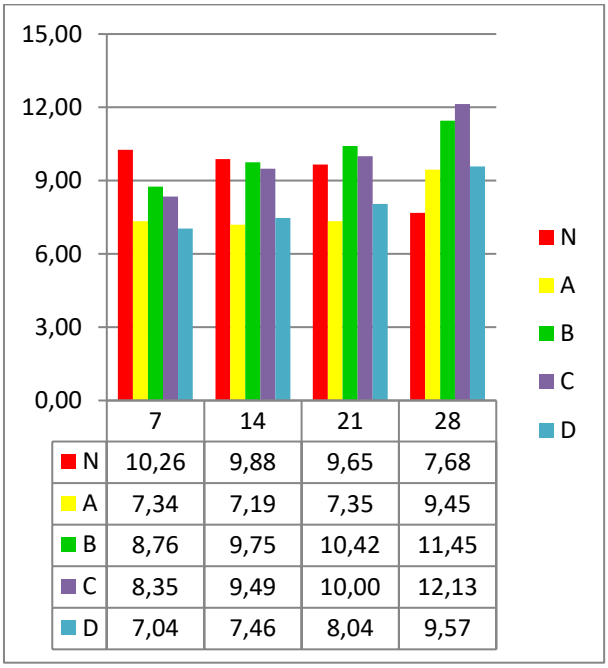


Figure 6. Slump Test Result
Source : Research Data

3.4. Strong Concrete Press Testing

The powerful testing of concrete press is done by using a test press tool with 12 concrete samples of each variation. 3 samples on day 7, to 14, to 21, to 28. Here are the results of a strong press test:



	7	14	21	28
N	10,26	9,88	9,65	7,68
A	7,34	7,19	7,35	9,45
B	8,76	9,75	10,42	11,45
C	8,35	9,49	10,00	12,13
D	7,04	7,46	8,04	9,57

Figure 7. Strong result Concrete Press
Source: Data Penelitian

From a strong test chart press the whole variation, it can be seen that the average strong press on the concrete subsitution of the 7th day, the 14th, the 21st, until the 28th is increased compared to with strong concrete press normal that has decreased from the 7th day to the 14th, 21st, until the 28th. The highest press strength is on day 28 is a concrete variation C with a mixture of Lime 10% + Glass 5% with a strong press of 12.13 Mpa

4. Conclusion

1. Lime as a cement substitution and glass as a gravel substitution that is soaked sulfuric acid can affect the strong press of concrete.
2. In the results of strong test press that has been done, on the 28th day of concrete substitutions are soaked sulfuric acid higher than normal concrete soaked sulfuric acid
3. In the research that has been done strong press highs found in the concrete variation C with a lime mixture 10% + glass 5% on day 28 with a strong press of 12.13 MPA higher than normal concrete ie 7.68 MPA on the 28th day
4. In research that has been done can be concluded that on the 28th day of the use of lime as a subsitution of cement and glass as a subsitution gravel can prevent acid sulfate attack with a rate of 2% compared to normal concrete in the sulfuric acid soak on the 28th day
5. Based on the results of concrete research with substituted material in the form of lime as a material substitution of cement and glass as a substitute material of gravel more efficiently used for the manufacture of non-structural concrete.
6. The increase in concrete substitutions are caused by lime calcium mixed with water during the mixing process due to lime calcium when given water will be lime extinguished or a base compound that is calcium hydroxide (Ca (OH2)) that can react with sulfuric acid compounds (H2SO4) with acid valence and base 2 so as to prevent attacks from the sulfuric acid

4.1. Advice

1. At the time of use of sulfuric acid as research should use PVC gloves and use chemical safety clothes.
2. In the weighing process materials, the scales must be at a weight of 0 Kg to fit the required material weight
3. During the mixing process using the mixer should be observed to make all the materials mixed evenly.
4. In concrete molding process, concrete compaction should be observed so that the resulting concrete is not bone loss that can affect the strong press concrete.

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Comparison the Analysis Results of Soil Improvement PVD Preloading & Stone Column Methods for Accelerating Soil Consolidation

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Abstract

The third runway plan for Soekarno-Hatta Airport will be right on land which is quite dominated by soft soil, which of course is very prone to large subsidence at a relatively slow time. Because the time factor is very narrow while the target is constantly being pursued, it is necessary to have an appropriate soil improvement method to overcome this problem. There are two options, (1) Prefabricated Vertical Draining (PVD) and (2) Stone Column. Both are installed in a triangle pattern at two different distances. The effectiveness analysis between the two was carried out based on references from FHWA (1983) and Priebe (1995). The final output of this final project report is the result of reduction obtained and the length of time required to achieve the degree of consolidation in accordance with the requirements, with comparisons based on the results shown by the time vs settlement curve. The author's initial hypothesis considers that the use of PVD is superior to the use of Stone Columns in this case because the decline time is faster even though the resulting decrease is not much different from that produced by Stone Column.

Keywords
Land subsidence, Consolidation Time, PVD, Stone Column

1. Introduction

The passenger growth rate which is predicted to continue to rise is the reason why PT Angkasa Pura II decided to build a third runway from Soekarno Hatta airport. This runway is expected to be able to meet the needs and accommodate the increasing number of passengers in the future. Therefore, a runway plan with high specifications was made, which would be able to accommodate large aircraft. This third runway is right on the north side of the airport, which is adjacent to Runway 2. However, the soil conditions in that area are mostly dominated by soft soil, with a little hard soil layer, as is the characteristic of the soil in Jakarta. These conditions make the possibility of a decline in danger lurking in the future. So that we need a soil improvement method that can accelerate the process of land subsidence so that the runway construction to be built will be safe.

There are two choices of soil improvement methods that can be used in this case, namely the Prefabricated Vertical Design (PVD) method and the Stone Column method. This method has advantages and disadvantages of each, so further analysis is needed to find the most effective and efficient method to use in this case.

This problem was also found in the case at the Samarinda Baru Airport Runway, which was built in 2013, where the planned runway to be built is right over an area dominated by soft soil. The planner chooses the PVD and Stone Column methods. PVD itself was chosen because it is widely used, but it is not able to increase soil bearing capacity. Unlike the stone column, which can increase the bearing capacity of the soil but is not effective if used at a certain depth.

Soil conditions in the Jakarta area are quite unique, because even though the soil is dominated by soft soil, it also has a hard soil layer (lens) so it needs more in-depth analysis to determine an effective and efficient soil improvement method. That is the aim of this research, where calculations based on the theories of one-dimensional consolidation on unimproved soil will be compared with the decrease that will be obtained if the soil improvement method in the form of PVD or Stone Column is used. The consolidated time rate curve is an output that will illustrate the analysis that will be carried out, to find the answer to this research hypothesis.

2. Theoris

. In general, land settlements caused by loading can be divided into two major groups, such as;

a. Consolidation Settlement = the result of changes in the volume of water saturated soil as a result of the discharge of water that occupies the soil pores.

b. Immediate Settlement = which is the result of elastic deformation of dry, wet and water saturated soil without any change in water content. The calculation of immediate reduction is generally based on the decrease derived from the elasticity theory.

The vertical consolidation coefficient (Cv) determines the velocity of water flowing in the vertical direction in the soil. Since consolidation generally takes place in one direction, that is, in a vertical direction, the coefficient of consolidation is very influential on the speed at which the consolidation will occur. The Cv can be found using the following equation:

$$Cv = \frac{Tv \times H^2}{t}$$

Cv = coefficient of consolidation (cm2/s)
Tv = time factor depending on the degree of consolidation
t = time taken to reach the degree of consolidation U% (s)
h = thickness of soil (cm)
The amount of consolidation reduction can be found using the equation:

$$s = \frac{Cc \times H}{1 + eo} log \frac{po + \Delta p}{po}$$

The amount of consolidation reduction can be found using the equation:
If (Po + P) <Pc

$$S = \frac{Cs}{1 + e_o} H \; log \frac{P_0 + \Delta p}{P_0}$$

If (Po + P)> Pc

$$S = \frac{Cs}{(1 + e_o)} H \log\left(\frac{P_0 + \Delta p}{P_0}\right) + \frac{Cc}{(1 + e_o)} H \log\left(\frac{P_0 + \Delta p}{P_0}\right)$$

Verruijt, (2010) proposed a theory for calculating the time of consolidation from one-dimensional consolidation for saturated clay soils. Several variables that are important to understand in determining the time and degree of consolidation according to Terzaghi (1925) will be defined below.

a. The compressibility coefficient can be defined as the average land subsidence shown by the change in the void ratio (Δe) to the change in stress (Δσ).
b. The Volume Compressibility Coefficient (mv) is the average decrease in soil volume relative to the initial thickness due to increased stress
c. The coefficient of consolidation defined in this section is the coefficient of consolidation due to vertical drainage.
d. The time factor is a dimensionless number.

The degree of consolidation states the percentage of consolidation that has occurred in a soil layer. Because the consolidation process is related to excess air pore dissipation, then at a depth z and time t

$$U_Z = \frac{u_o + u_z}{u_o}$$

Meanwhile, according to Technology, (n.d.), the degree of consolidation for 0% <U <100%

$$\frac{U\%}{100} = \frac{\left(\frac{4T_v}{\pi}\right)^{0,5}}{[1 + \left(\frac{4\mathrm{Tv}}{\pi}\right)^{2,8}]^{0,179}}$$

$$T_v = \frac{\left(\frac{\pi}{4}\right) \times \left(\frac{U\%}{100}\right)^2}{[1 - (100 - \mathrm{U}\%)^{5,6}]^{0,357}}$$

2.1 Prefabricated Vertical Drain

The theory and analysis developed in calculating the effect of PVD on the degree of consolidation assumes that PVD is circular. Lastiasih et al., (2017) suggested that if the circumference of the band-shaped and circle of the PVD were the same, it would result in the same degree of consolidation.

The equation of the degree of consolidation in stabilized soil using the PVD system according to Carrillo in Maiti & Bidinger (1981) is as follows:

$$U_c = 1 - (1 - U_h)(1 - U_v)$$

Where :
Uc = degree of soil consolidation due to vertical and radial flows.
Uh = degree of radial consolidation
Uv = degree of vertical consolidation.
The amount of time to consolidate due to the use of PVD is determined using the equation:

$$t = \left(\frac{D^2}{8 \times Ch}\right) \times 2F(n) \times \ln\left(\frac{1}{1 - U_h}\right)$$

Where :
t = the time it takes to reach Uh (s)
D = the circle's equivalent diameter (cm)
1.13 x S for rectilinear pattern
1.05 x S for triangular arrangement
Ch = horizontal flow consolidation coefficient (cm2 / s)
F (n) = the drag factor caused by the distance between the PVDs.
Uh = degree of horizontal soil consolidation (%)

2.2 Stone Column

Soil subsidence resulting from the use of a stone column must pay attention to the push factor (punching), so that the calculation in this method the improvement factor n2 is used to reduce soil subsidence.

Broadly speaking, the analyzed land subsidence is divided into 3 types;

1. Soil subsidence in layers reinforced by stone columns
   In this section, land subsidence can use terzhagi theory by using $n2$ to reduce soil subsidence that occurs for conditions without a reinforced stone column.
2. Soil subsidence in layers that are not reinforced by stone columns
   In this section, the working stress is equal to the total working load, σ
3. Soil subsidence due to the effect of punching on the stone column
   Soil subsidence due to punching can be calculated using the principle of land subsidence due to loading on the deep foundation, where the load works at a depth of 2/3 of the stone column length and uses the 2: 1 method for stress distribution at each depth.

Then the predicted amount of land subsidence due to the punching can be calculated through the equation

$$S'_p = \frac{S_p \times S_0}{(S_p + S_0)}$$

Where
S'_p = decrease due to reduced punching
S_p = decrease due to calculated punching
S_0 = settlement in the reinforced soil layer prior to the stone column

3. Result and Analysis

The results of the tests / observations were compared with the calculations obtained based on initial theory and literature review. Then the two results (calculation and testing) are compared again, whether they meet the requirements in the initial plan / specification. This end result will form the basis for drawing conclusions to answer research questions and hypotheses.

The object of this case study is located in Tangerang, West Java, namely the construction of Runway 3 at Soekarno Hatta International Airport. The Runway development is divided into 2 parts, where the Section 1 is the object of the case study in this final project.

The runway is planned to span 3000 meters with a width of 60 meters. The data used are soil data on the runway plan STA 0 + 250 to STA 1 + 100, so it is known that there are 4 SPTs conducted at 3 bore hole points out of a total of 75 bore hole points made along the runway area. The bore hole points that are used as the basis for the analysis in this final project are;

a. DB-01 at station 0 + 540
b. DB-03 at station 0 + 740
c. DB-06 at station 1 + 020

While the loads that are planned for the runway design are;

a. Equivalent pavement load = 24 kN / m2
b. Aircraft equivalent load = 15 kN / m2

The load is calculated for the planned runway design, which is 3000 m long with 60 m long shoulders. While the design standards used to design runways are AC 150 / 5300-13, Airport Design, a guideline published by the FAA (Federal Aviation Administration) in 2012 that has been updated 15 times since it was first published in 1989.

After knowing the soil data and its interpretation, as well as a cross section plan, it can be concluded that the parameters will be used as a design reference. The selection of parameters and soil profiles that are used as references is found at the DB-06 bore hole at station 1 + 020

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These points are selected based on the depth of the largest layer of soft clay and the elevation of the elevation embankment. Therefore, it is obtained soil parameters for design reference and soil profile;

Table 1. Mohr-Coulomb modeling design reference parameters

PARAMETER			EMBANK-MENT	1st Soil Layer	2nd Soil Layer	3rd Soil Layer
Model			MC	MC	MC	MC
Soil Sample Type			Drained	Undrained	Drained	Drained
Soil Density (Underwater)	γ_{unsat}	kN/m^3	14,51	16,93	17,9	15,4
Soil Density	γ_{sat}	kN/m^3	14,51	21,95	22,4	19
Permeability x	k_x	m/day	0,864	0,00864	0,864	0,864
Permeability v	k_y	m/day	0,864	0,00864	0,864	0,864
Modulus of Elasticity (stiffness)	E_u	kN/m^2	13000	1500	8000	14000
	E'	kN/m^2	13000	1500	8000	14000
Poisson's Ratio	υ (μ)		0,3	0,2	0,35	0,4
Soil cohesion	C_{ref}	kN/m^2	0	5	52,1	26,3
Inner sliding angle	φ		35	10	5	3
Dilation angle (psi)	ψ	(*6,9 kN/m2)	0	0	0	0

Table 2. Soft Soil modeling design reference parameters

PARAMETER			EMBANK-MENT	1st Soil Layer	2nd Soil Layer	3rd Soil Layer
Model			SS	SS	SS	SS
Soil Sample Type			Drained	Undrained	Drained	Drained
Soil Density (Underwater)	γ_{unsat}	kN/m^3	14,51	0,00	17,9	15,4
Soil Density	γ_{sat}	kN/m^3	14,51	9,80	22,4	19
Permeability x	k_x	m/hari	0,864	0,00864	0,864	0,864
Permeability v	k_y	m/hari	0,864	0,00864	0,864	0,864
Compression Index	Cc		0,32	0,23	0,23	0,76
Swelling Index	Cs		0,064	0,046	0,046	0,152
Initial Void Ratio	eo		0,8	0,82	0,94	1,89
Cohesion	C	kN/m^2	52,1	52,1	52,1	26,3
Inner sliding angle	φ		35	10	5	3
Dilation angle (psi)	ψ		0	0	0	0

3.1 Unimproved Soil Conditions

In this analysis, the operational embankment design is calculated based on the equivalent height of the following factors, namely;

a. Land Elevation = 3 m; bj of land = 15 kN / m2
b. Sand Blanket = 1 m; bj of sand = 18 kN / m2
c. Pavement = 0.8 m; bj of concrete = 24kN / m2
d. Airplane = 15 kN / m2

So, the equivalent height of the factors above is;

a. Pavement equivalent height $= \frac{24\ \text{kN/m}^2}{15\ \text{kN/m}^2} \times 0{,}8\ m = 1{,}28$ m
b. Plane equivalent height $= \frac{\gamma\ \text{plane}}{\gamma\ \text{embankment}} = \frac{15\ \text{kN/m}^3}{15\ \text{kN/m}^2} = 1\ m$

So, the required heap height, namely;

H embankment = 0.6 m + 3 m + 1 m + 1.28 m = 5.88 m

In order to overcome the excess load when the runway starts to operate, the design of the planned embankment must be larger than the operational embankment size, so that the total embankment height is = 6.5 m. The stockpiling is carried out in stages, where the stage 1 = up to 3 meters, and the second stage is up to 6.5 meters.

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The analysis of land subsidence using the following manual calculation refers to the theory of one-dimensional consolidation by Terzaghi, where the increase in vertical stress on the soil under the embankment is caused by the loading of the embankment itself. So that the following table can be obtained;

Table 3. Calculation of Land Subsidence Due to 1ST Embankment Layer

Depth Interval M			γ_m	σo'	Δσo (Elevation of Embankment)			Cc	eo	Sc
					qo	I	Δσo			
			kN/m3	kN/m2	kN/m2		kN/m2			M
0	-	1	16,93	16,93	46,52308	0,458	46,06508	0,32	1,29	0,079741
1	-	2	16,93	33,86	46,52308	0,458	46,06508	0,32	1,29	0,052122
2	-	3	16,93	50,79	46,52308	0,458	46,06508	0,32	1,29	0,039175
3	-	4	16,93	67,72	46,52308	0,458	46,06508	0,32	1,29	0,031493
4	-	5	16,93	84,65	46,52308	0,458	46,06508	0,32	1,29	0,026368
5	-	6	17,9	102,55	46,52308	0,458	46,06508	0,32	1,29	0,022516
6	-	7	17,9	120,45	46,52308	0,458	46,06508	0,32	1,29	0,019654
					46,52308		**Total Settlement**			**0,271068**
7	-	8	15,43	135,88	46,52308	0,458	46,06508	0,32	1,29	0,017717
8	-	9	15,43	151,31	46,52308	0,458	46,06508	0,32	1,29	0,016129
9	-	10	15,43	166,74	46,52308	0,458	46,06508	0,32	1,29	0,014804
					46,52308		**Total Settlement**			**0,048650**
10	-	11	15,43	182,17	46,52308	0,458	46,06508	0,32	1,29	0,013681
11	-	12	15,43	197,6	46,52308	0,458	46,06508	0,32	1,29	0,012717
12	-	13	15,43	213,03	46,52308	0,458	46,06508	0,32	1,29	0,011880
13	-	14	15,43	228,46	46,52308	0,458	46,06508	0,32	1,29	0,011147
14	-	15	15,43	243,89	46,52308	0,458	46,06508	0,32	1,29	0,010499
15	-	16	15,43	259,32	46,52308	0,458	46,06508	0,32	1,29	0,009923
16	-	17	15,43	274,75	46,52308	0,458	46,06508	0,32	1,29	0,009407
17	-	18	15,43	290,18	46,52308	0,458	46,06508	0,32	1,29	0,008942
18	-	19	15,43	305,61	46,52308	0,458	46,06508	0,32	1,29	0,008520
19	-	20	15,43	321,04	46,52308	0,458	46,06508	0,32	1,29	0,008137
20	-	21	15,43	336,47	46,52308	0,458	46,06508	0,32	1,29	0,007787
21	-	22	15,43	351,9	46,52308	0,458	46,06508	0,32	1,29	0,007466
22	-	23	15,43	367,33	46,52308	0,458	46,06508	0,32	1,29	0,007170
23	-	24	15,43	382,76	46,52308	0,458	46,06508	0,32	1,29	0,006897
24	-	25	15,43	398,19	46,52308	0,458	46,06508	0,32	1,29	0,006643
25	-	26	15,43	413,62	46,52308	0,458	46,06508	0,32	1,29	0,006408
26	-	27	15,43	429,05	46,52308	0,458	46,06508	0,32	1,29	0,006189
27	-	28	15,43	444,48	46,52308	0,458	46,06508	0,32	1,29	0,005985
28	-	29	15,43	459,91	46,52308	0,458	46,06508	0,32	1,29	0,005793
29	-	30	15,43	475,34	46,52308	0,458	46,06508	0,32	1,29	0,005613
								Total Settlement		**0,170805**
								Total ALL Settlement		**0,490523**

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Table 4. Calculation of Land Subsidence Due to 2nd Embankment Layer

Depth Interval m			γm	σo'	Δσo (Timbunan Elevasi)			Cc	eo	Sc
					qo	I	Δσo			
			kN/m3	kN/m2	kN/m2		kN/m2			m
0	-	1	16,93	16,93	100,8	0,458	100,342	0,32	1,29	0,117455
1	-	2	16,93	33,86	100,8	0,458	100,342	0,32	1,29	0,083573
2	-	3	16,93	50,79	100,8	0,458	100,342	0,32	1,29	0,066177
3	-	4	16,93	67,72	100,8	0,458	100,342	0,32	1,29	0,055162
4	-	5	16,93	84,65	100,8	0,458	100,342	0,32	1,29	0,047445
5	-	6	17,9	102,55	100,8	0,458	100,342	0,32	1,29	0,041408
6	-	7	17,9	120,45	100,8	0,458	100,342	0,32	1,29	0,036776
							Total Settlement			0,447996
7	-	8	15,43	135,88	100,8	0,458	100,342	0,32	1,29	0,033560
8	-	9	15,43	151,31	100,8	0,458	100,342	0,32	1,29	0,030873
9	-	10	15,43	166,74	100,8	0,458	100,342	0,32	1,29	0,028591
							Total Settlement			0,093024
10	-	11	15,43	182,17	100,8	0,458	100,342	0,32	1,29	0,026628
11	-	12	15,43	197,6	100,8	0,458	100,342	0,32	1,29	0,024922
12	-	13	15,43	213,03	100,8	0,458	100,342	0,32	1,29	0,023423
13	-	14	15,43	228,46	100,8	0,458	100,342	0,32	1,29	0,022096
14	-	15	15,43	243,89	100,8	0,458	100,342	0,32	1,29	0,020913
15	-	16	15,43	259,32	100,8	0,458	100,342	0,32	1,29	0,019851
16	-	17	15,43	274,75	100,8	0,458	100,342	0,32	1,29	0,018893
17	-	18	15,43	290,18	100,8	0,458	100,342	0,32	1,29	0,018023
18	-	19	15,43	305,61	100,8	0,458	100,342	0,32	1,29	0,017231
19	-	20	15,43	321,04	100,8	0,458	100,342	0,32	1,29	0,016505
20	-	21	15,43	336,47	100,8	0,458	100,342	0,32	1,29	0,015839
21	-	22	15,43	351,9	100,8	0,458	100,342	0,32	1,29	0,015225
22	-	23	15,43	367,33	100,8	0,458	100,342	0,32	1,29	0,014656
23	-	24	15,43	382,76	100,8	0,458	100,342	0,32	1,29	0,014129
24	-	25	15,43	398,19	100,8	0,458	100,342	0,32	1,29	0,013639
25	-	26	15,43	413,62	100,8	0,458	100,342	0,32	1,29	0,013181
26	-	27	15,43	429,05	100,8	0,458	100,342	0,32	1,29	0,012754
27	-	28	15,43	444,48	100,8	0,458	100,342	0,32	1,29	0,012353
28	-	29	15,43	459,91	100,8	0,458	100,342	0,32	1,29	0,011977
29	-	30	15,43	475,34	100,8	0,458	100,342	0,32	1,29	0,011623
							Total Settlement			0,343861
							Total ALL Settlement			0,884881

This consolidation time calculation refers to the theory put forward by Terzaghi, namely one-dimensional consolidation, shown in the following graphs and tables;

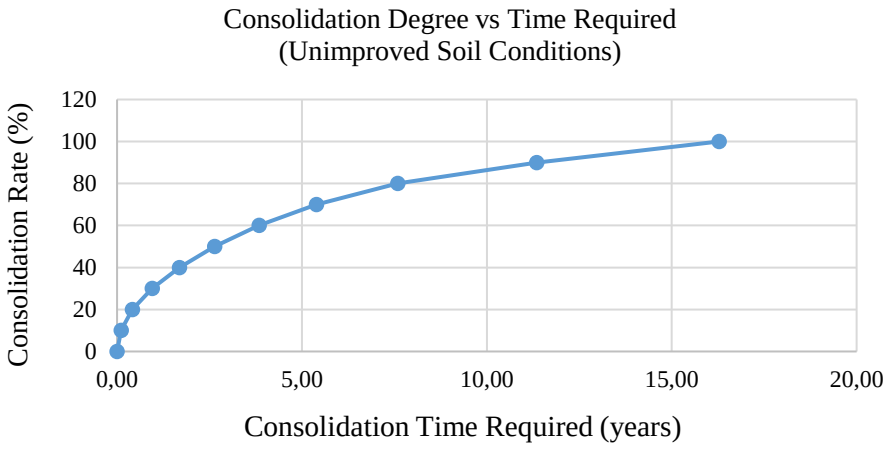

Figure 1. Consolidation Curves for Original Soil Conditions

Step to:	H Embankment m	Land subsidence (m) 1-D Consolidation	PLAXIS 2D (MC)	PLAXIS (SS)
1	3	0,490523	0,424330	0,529300
2	6,5	0,884881	0,774950	0,842380

Figure 2. Resume Land Subsidence of Unimproved Soil conditions

This graph shows that the original soil which is not reinforced / soil improvement to reach a consolidation degree of 90% requires a consolidation period of up to 11 years. This is certainly not feasible to do so soil improvement is needed to accelerate the consolidation that occurs

3.2 The Effectiveness of Using PVD

In analyzing the effectiveness of the use of PVD, what needs to be considered is the construction time and land subsidence that will occur if the PVD is given to a land to accelerate the consolidation process. In this case, the following PVD specifications are used

Table 5. PVD specifications used

Parameter	Nilai	
Tipe	Daehan V-Dek-706	
a	100	mm
b	3,39	mm
dw	52	mm
Panjang	10	m
S	1000	mm
Pola Pemasangan	Segitiga	
de	1050	mm

The calculation of the time of consolidation in the soil given by PVD is based on the theory of Barron and Hansbo, which considers the effect of the radial direction drainage factor on the consolidation that occurs. The following is a table of the results of calculating the time for land consolidation given by PVD

Table 6. Calculation of Consolidation Time with PVD

Ur %	Th	Uv %	Tv	U(v,r)	t detik	hari	bulan	tahun
0,000	0,000	0,000%	0	0,000	0	0,00	0,00	0,00
0,050	0,014	0,002%	9E-11	0,050	44284	0,51	0,03	0,00
0,100	0,030	0,003%	1,8E-10	0,100	90964	1,05	0,05	0,00
0,150	0,046	0,004%	2,7E-10	0,150	140312	1,62	0,08	0,01
0,200	0,063	0,004%	3,6E-10	0,200	192653	2,23	0,11	0,01
0,250	0,081	0,005%	4,5E-10	0,250	248373	2,87	0,14	0,01
0,300	0,101	0,005%	5,4E-10	0,300	307938	3,56	0,18	0,01
0,350	0,121	0,005%	6,3E-10	0,350	371920	4,30	0,22	0,02
0,400	0,144	0,006%	7,2E-10	0,400	441025	5,10	0,26	0,02
0,450	0,169	0,006%	8,1E-10	0,450	516147	5,97	0,30	0,02
0,500	0,195	0,006%	9E-10	0,500	598434	6,93	0,35	0,03
0,550	0,225	0,007%	9,9E-10	0,550	689398	7,98	0,40	0,03
0,600	0,258	0,007%	1,08E-09	0,600	791087	9,16	0,46	0,04
0,650	0,296	0,007%	1,17E-09	0,650	906372	10,49	0,52	0,04
0,700	0,339	0,008%	1,26E-09	0,700	1039459	12,03	0,60	0,05
0,750	0,391	0,008%	1,35E-09	0,750	1196868	13,85	0,69	0,06
0,800	0,454	0,008%	1,44E-09	0,800	1389521	16,08	0,80	0,07
0,850	0,535	0,008%	1,53E-09	0,850	1637893	18,96	0,95	0,08
0,900	0,649	0,009%	1,62E-09	0,900	1987955	23,01	1,15	0,10
0,950	0,845	0,009%	1,71E-09	0,950	2586388	29,94	1,50	0,12
1,000	2,597	0,009%	1,8E-09	1,000	7951818	92,03	4,60	0,38

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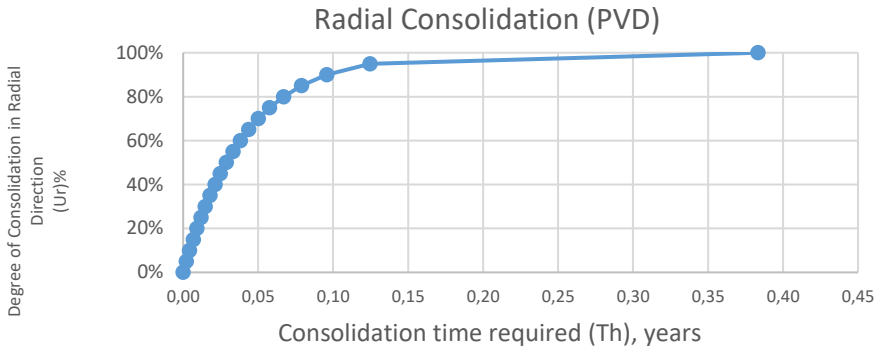

Figure 3. the results of the calculation of the time for land consolidation given by PVD

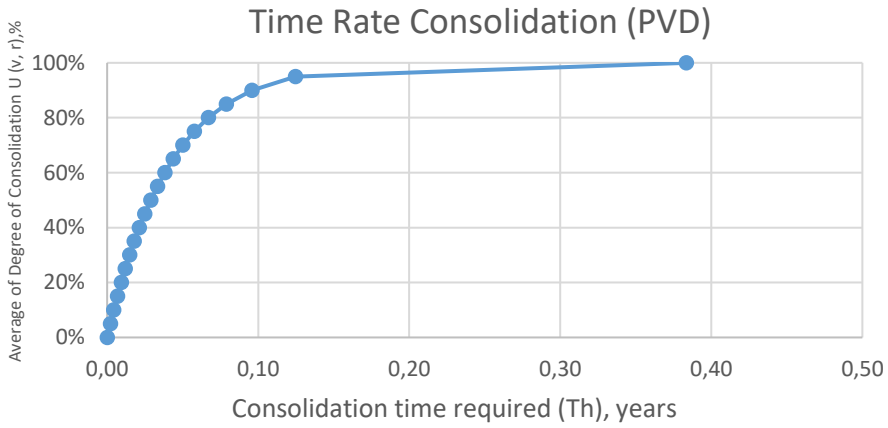

Figure 4. Time of Condition Consolidation with PVD Reinforcement

Based on the two graphs above, it is known that the degree of consolidation on the soil which is reinforced with PVD will be generated on the day

U (v, r) = 80% → t = 16 days

U (v, r) = 90% → t = 23 days.

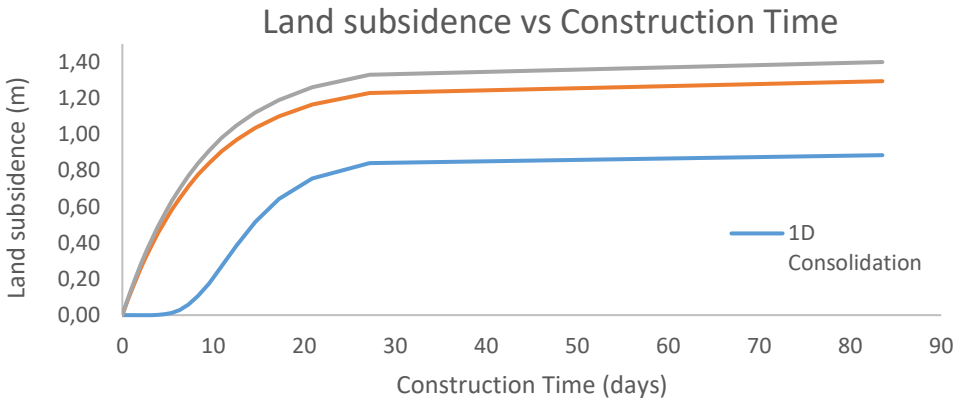

Figure 5. Time Rate of Condition Consolidation with PVD Reinforcement

Acceleration of consolidation can occur in soil that is given PVD, due to the flow of water from the soft soil layers that can be channeled through the planted bands. These bands act as "paths" that accelerate the process of pore water discharge from the soft soil layer, where soil grains can be retained through the geotextile layer that covers the band.

The process of installing PVD causes the soil to become “disturbed”, so it is necessary to take into account the possible conditions for the area affected by this. This affected area will change the permeability coefficient. This change can be obtained from the above calculations, so that the influence factor is found in the form of the degree of consolidation in the radial direction.

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3.3 Effectiveness of Using Stone Columns

In this case study, the Stone Column used has specifications;

Table 7. Stone Column specifications used

Parameter	Nilai	
D	500	mm
L	6	m
Φc	42	o
Ec	100000	kN/m^2
Dc	120000	mm
Vc	0,25	
Spasi	1,5	m
Pola Pemasangan	Segitiga	

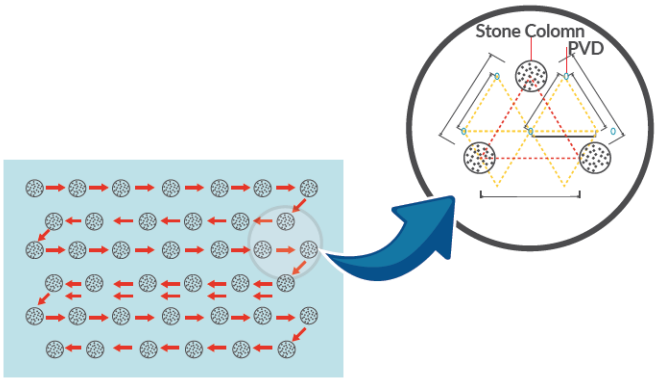

Figure 6. The pattern of stone column

The land subsidence that occurs is divided into 3 parts, among others;

a. Soil subsidence in areas reinforced by stone columns (Su)
The decrease that occurs can use the amount of improvement factor that has been sought ($n2$).

b. Land subsidence in areas that are not reinforced by stone columns (Sl)
The amount of land subsidence under the stone column was calculated using Terzaghi's theory of one-dimensional consolidation.

c. Additional land subsidence due to punching ($S'p$)
Because the soft soil under the stone column is considered unable to withstand the stress concentration in the stone column, it can be assumed that the stone column will compress the soil layer directly below it.

The following is the result of calculating the total reduction using the Priebe method;

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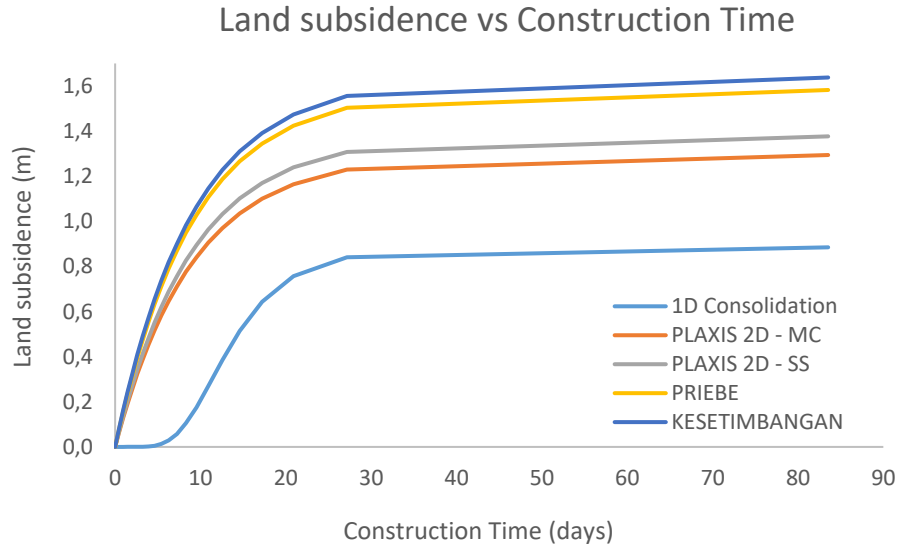
Table 8. Table of Construction Time needed to get the degree of descent based on each method

Hari		1D-Consolidation	PRIEBE	KESETIM-BANGAN	PLAXIS MC	PLAXIS SS
0,0000	0%	0,000	0,000	0,000	0,000	0,000
0,4652	5%	0,000	0,079	0,082	0,065	0,069
0,9556	10%	0,000	0,158	0,164	0,129	0,138
1,4740	15%	0,000	0,237	0,246	0,194	0,207
2,0239	20%	0,000	0,316	0,328	0,259	0,275
2,6092	25%	0,000	0,396	0,409	0,324	0,344
3,2350	30%	0,001	0,475	0,491	0,388	0,413
3,9071	35%	0,002	0,554	0,573	0,453	0,482
4,6331	40%	0,005	0,633	0,655	0,518	0,551
5,4223	45%	0,013	0,712	0,737	0,582	0,620
6,2867	50%	0,029	0,791	0,819	0,647	0,688
7,2423	55%	0,058	0,870	0,901	0,712	0,757
8,3106	60%	0,105	0,949	0,983	0,776	0,826
9,5217	65%	0,176	1,029	1,065	0,841	0,895
10,9198	70%	0,270	1,108	1,146	0,906	0,964
12,5735	75%	0,386	1,187	1,228	0,971	1,033
14,5973	80%	0,514	1,266	1,310	1,035	1,102
17,2066	85%	0,643	1,345	1,392	1,100	1,170
20,8841	90%	0,757	1,424	1,474	1,165	1,239
27,1708	95%	0,841	1,503	1,556	1,229	1,308
83,5363	100%	0,885	1,582	1,638	1,294	1,377

The amount of land subsidence obtained using 3 calculation methods, namely the Priebe method, equilibrium method, and modeling in PLAXIS for each stage can be seen in the following table and figure below.

Table 9. Resume of Land subsidence by Stone Column

Resume Penurunan Tanah						
Tahap ke	H Timbunan	Penurunan Tanah (m)				
	m	1-D Consolidation	Priebe	Kesetim - bangan	PLAXIS 2D (MC)	PLAXIS 2D (SS)
1	3,0000	0,4905	0,8407	1,1020	0,8937	1,1653
2	6,5000	0,8849	1,5824	1,6378	1,2940	1,3769



By using a space of 1.5 meters, Stone Column is able to accelerate the consolidation process to reach

a. U = 80% → t = 18 days
b. U = 90% → t = 26 days

Consolidation acceleration can occur in soils given Stone Columns, because stone columns can also drain water on soft soils with overconsolidated conditions. Water that is difficult to move because the soil is too fine can find its way to the surface through the installed stone column. In addition, the soil pressure can also increase the carrying capacity. However, the permeability coefficient of a stone column with PVD itself is different, so the use of these two materials needs to be considered carefully.

4. Conclusion

1) Pada hasil analisis data awal, tanah tanpa mengalami perkuatan tanah memerlukan jumlah tahapan timbunan sebanyak 4 kali untuk mencapai ketinggian timbunan 6,5 meter, dengan tahap 1 = 3m, dan tahap 2 = 6,5 m. Setelah dilakukan analisis, waktu konsolidasi vertical didapatkan nilai;

a. U = 80% → t = 7.5 years
b. U = 90% → t = 11.3 years

2) So it was concluded that to reach the heap height of 6.5 meters with the consolidation time for each stage is determined to be 80% and at the end of the embankment stage 90% of the consolidation will be waited for a construction time of 18.8 years (7.5 years + 11.3 years) and this is not feasible to do in the field.
3) The existence of PVD proved to be quite effective in accelerating the consolidation process that occurred. The contribution of radial drainage can accelerate the consolidation process. By using 1 meter PVD spacing is able to accelerate the consolidation process to reach

a. U = 80% → t = 16 days
b. U = 90% → t = 23 days

Even though it is able to accelerate the consolidation process, PVD does not have a direct effect in increasing the bearing capacity of the soil, so that 2 stages of embankment are still needed to reach a height of 6.5 meters with a total construction time of 39 days (16 days + 23 days)

4) Stone Column proved to be quite effective in increasing bearing capacity and accelerating the consolidation process. By using a space of 1.5 meters, Stone Column is able to accelerate the consolidation process to reach

a. U = 80% → t = 18 days
b. U = 90% → t = 26 days

So the total construction time = 44 days (18 days + 26 days)

5) Based on the large resume table of land subsidence with construction time, it can be concluded that the PVD method of soil improvement produces 5 days faster consolidation time when compared to the Stone Column method.
6) If the time required to carry out all of these soil improvements in the field is for a month, then it is necessary to consider choosing the PVD method as the soil improvement method, because the resulting consolidation time is faster and the cost is cheaper when compared to the Stone Column method.

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Analysis Foundation Planning Bored Pile Pier P1 Sta 8+442 Project Toll Road Depok – Antasari Section Ii

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Abstract

The purpose of this study is to plan a construction stability of the upper and lower structures in the construction of the Depok - Antasari toll road section II, especially in the planning of a foundation. The foundation used in pier p1 is the foundation in the bored pile type. In planning the foundation, it is necessary to take into account the load force acting on the pier, the bearing capacity of the foundation piles, and the settlement. Analysis of bridge loading calculation (Badan Standarisasi Nasional, 2008) and (Badan Standarisasi Nasional, 2008) using a software program, namely SAP 2000 v.20. The purpose of this loading analysis is to find the value of the pier bearing reaction force to the working forces, both from the fixed load force and the environmental action load. In order for the purpose of this study to be achieved, literature studies from various sources both from the Indonesian National Standard and various other sources discuss the planning of foundation calculations, namely the AASHTO, Kullhawy, Vesic and Reese Wright methods. The results of this study explain that it must be paid attention to planning a foundation that meets the parameters and structures that are safe against earthquakes and other loads, it is also necessary to take into account the momentary reaction force, bearing capacity of the pile and land subsidence according to national standards.

Keywords
Bearing Capacity, Foundation Planning, Settlement, SAP 2000

1. Introduction

The Toll Road Development Project is one of the infrastructure developments that functions to progress in the construction sector and the economic sector. Some important things from development include the socio-economic field of society, memudahkan masyarakat untuk bisa melakukan especially in transportation. The government has carried out various developments in order to make it easier for the community to be able to carry out their maximum mobility both in the economic and social fields Based on data from the Jakarta Transportation Statistics, from 2012 to 2019 the growth of traffic in Jakarta has an average growth of 5.3 persen. The number of motorbikes in 2019 is said to have reached 14.74 million units. Compared to the circulation of passenger cars in the same period, the average growth was smaller, namely 3.99 million units. However, this growth was not accompanied by the development of supporting infrastructure, especially roads, while the annual increase in road area was only 0.01% throughout Jakarta, so it can be estimated that in about 10 years Jakarta will be totally congested which will affect economic growth and development in Jakarta, which is the center. Indonesia's economic pace. These losses can be in the form of decreased work productivity due to wasted time on the road and wasted fuel (Badan Pusat Statistik DKI Jakarta, 2018)

The construction of the Depok - Antasari (Desari) elevated toll road is an alternative due to the limited availability of land in the city of South Jakarta as well as a connection to the city of Depok and its surroundings. The construction of the elevated toll road construction must meet the stability of the construction in terms of the upper structure and the sub-structure. Experience the impact of performance in the field in the procurement of equipment at the project location. In addition, the contractor also has difficulty implementing the tool procurement flow quickly, easily & efficiently. To pass the load from the upper structure to the soil layer below it until it reaches the desired carrying capacity, a sub structure is needed. which is called the foundation. The foundation to be used in the Depok - Antasari toll road construction project on pier P1 sta 8 + 442 is the inner foundation, namely the tipebor pile.

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2. Study of Literature

(Hary Christady Hardiyatmo, 2010) explains that the foundation is the lowest structural component of a building that transmits the load of the building to the soil or rock underneath. The foundation is made into a solid building block under construction. The foundation can be defined as the bottom part of a strong and stable construction (solid).

A bored pile foundation is a deep foundation whose construction is carried out in the following stages :

Drilling until hard soil layers. To find out the depth of hard soil, it can be done by using the sondir test or Standard Penetration Test (SPT).

Insertion of fabricated reinforcement into boreholes and,

Casting.There are several types of drill poles

according to how to transfer structural loads to subgrade (Das, 2011), namely :

1. Straight Pole Drill
   The drill pole is made straight through the soft soil layer and the tip lies in the hard soil layer. The bearing capacity of this foundation lies in the end resistance and friction resistance between the surface of the drill pile and the ground.
2. Drill Pole with enlarged tip
   The end of the foundation is enlarged to form a dome or trapezoid. Judging from the shape, the overall bearing capacity of this foundation comes from the end of the pile. However, in some cases, the friction resistance between the blanket and the ground is also taken into account.
3. The Drill Pole goes straight into the rocky layer
   The end of the drill pile can enter into the rocky layer. For the calculation of the bearing capacity in a case like this, the end of the pile and the friction between the rock and soil along the pile can be taken into account. The three types of drill piles described above are illustrated in Figure 2.1

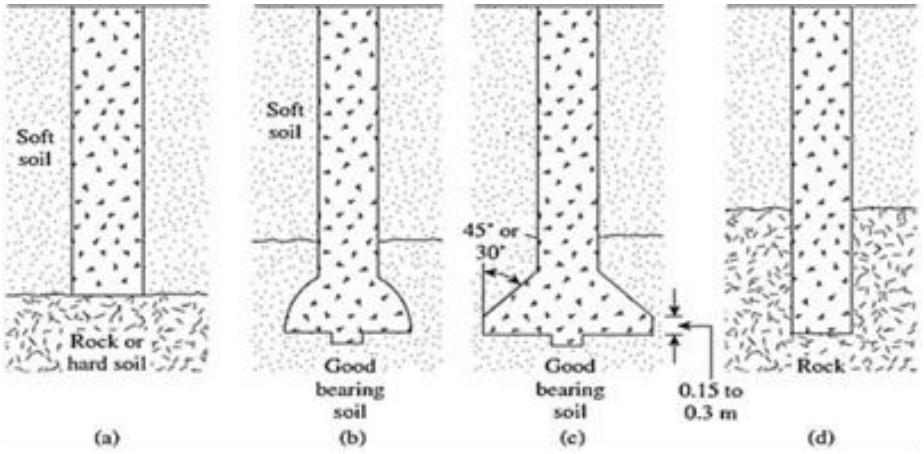


Figure 1. Drill Pole Type
Source : Das, B.M. 2011

3. Results and Analysis

This planning study will be carried out with a data analysis procedure which is divided into several stages, including:

1. Taking into account the value of loads based on (Badan Standarisasi Nasional, 2008) for earthquake loading and (Bambang Dewasa, 2016)for loading on bridges.
2. Modeling of foundations, in this stage modeling is carried out with the help of the SAP 2000 V.20 program, the output produced by the program is the amount of load received by the foundation in the form of vertical, horizontal, and moment force bearing capacity of the foundation piles.
3. Comparison of the results of the calculation of carrying capacity with the results of the PDA (pile driving analyzer) test to find the value of the vertical bearing capacity of the pile based on N-SPT data.
4. Analyze bearing capacity for drill pile using AASHTO method
5. The equation for finding the value of the lateral (horizontal) bearing capacity using the Broms Method.
6. Analysis to obtain the allowable reduction according to the plan data uses the Vesic Method equation.

Loading calculation analysis refers to the Loading Regulation (Bambang Dewasa, 2016)concerning Loading for bridges. The purpose of this loading analysis is to find the reaction force of the pier support against

the working forces, both the force originating from the fixed load, namely the structure's own weight and the live load in the form of a vehicle and environmental action consisting of wind, earthquake and vehicle collisions with using the SAP 2000 v.20 program (Bambang Dewasa, 2016)

3.1 Dead Load

Table 1. Calculation of Additional Dead Load

URAIAN	DIMENSI		Ac	Volume	Berat	Jumlah	Faktor Beban	Total
	P (M)	Dia						
Paraphet	41		0,06	2,46	5,9	2	2	23,62
Pipa Sparing	41	0,12	0,0011	0,05	0,36	2	2	1,42
Planter Box	41		0,06	2,46	19,31	2	2	77,24
Pile Cap	6,7		11,725	78,56	188,54	1	1,2	226,25
Timbuhan Tanah	6,7		6,7	44,89	71,82	1	1,2	86,19
							Total Beban	414,72

source : SNI-1725:2016

BJ Concrete : 2,4 tons/m3
BJ Land Fill : 1,6 tons/m3
BJ Iron / Steel : 7,85 tons/m3

3.2 Life Load

1) Lane Load

Line load (BGT) with an intensity P is taken as P = 49 kN / m or P = 4.9 tons/ m.

a. The sock factor

Load P is increased by the correlation on the shock load reference diagram (D), as in Figure 4.1 below

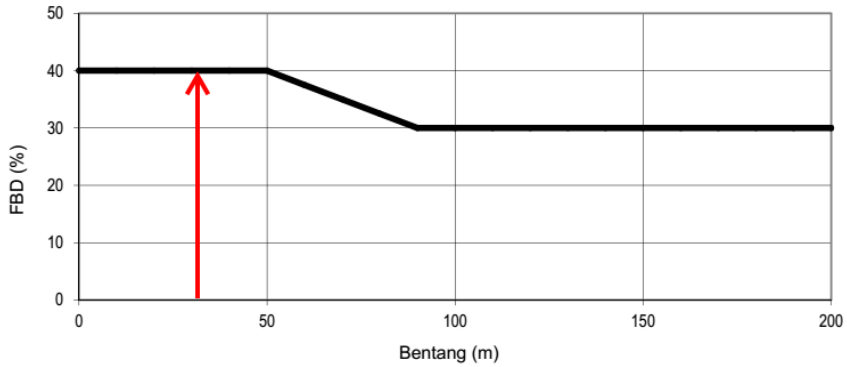


Figure 2. Shock load reference diagram

Based on the diagram with a span length of 41 m, the dynamic load factor is 40% or the multiplier factor = 1.4 for the intensity P.

b. The line load of large vehicles (P) with shock loads (TTD) with a length of 41 m.
D = P x soc factor = 4,9 t/m x 1,4 = 6,86 t/m

c. Spread the load D in the transverse direction
Styles that work 100% as wide:
D100% = n lane x 2.75 m = 3 x 3.25 1 = 9.75 m
= 100% x PLL = 100% x 6.86 = 6.86 t / m

Style that works 50% as wide :
D50% = lane width - 8.25 m = 16 m - 9.75 m = 6.25 m
= 50% x PLL = 50% x 6.86 = 3.43 t / m

3.3 Environmental Action Expenses

1. Wind Load (TEW)

Calculating the design wind speed (Bambang Dewasa, 2016)
VDZ = 2,5.Vo . (V10/VB). In(Z/Z0)
= 2,5 x 19,3 (90/90) x In (11300/2500)
= 72,79 Km/hour
Calculating the planned wind pressure (Bambang Dewasa, 2016)
PD = PB (VDZ/VB)2
= 0,0024 (72,79/90)2
= 0,002 MPa
Based on(Bambang Dewasa, 2016), the wind force of 4.4 kN / mm is used

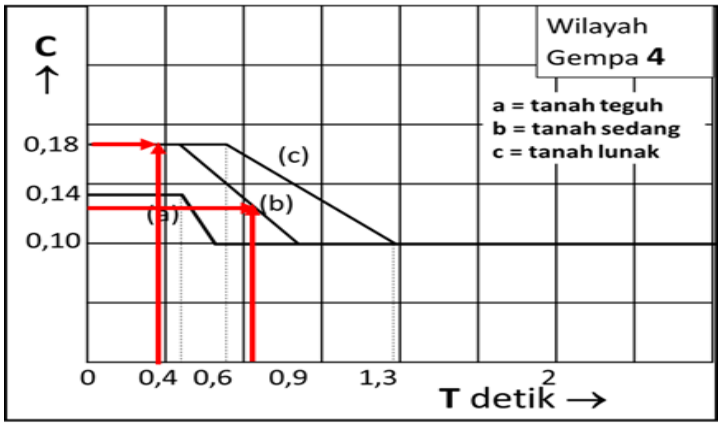
2. Earthquake Load

$$T_{trans} = 2\pi\sqrt{\frac{W_{TP}}{g.K_p}} = 2\sqrt{\frac{1383,37}{9,81x37448,53}}$$

= 0,39 second

$$T_{long} = 2\pi\sqrt{\frac{W_{TP}}{g.K_p}} = 2\pi\sqrt{\frac{1383,37}{9,81x12027,14}}$$

= 0,68 second



.Figure 3. Determining the basic shear coefficient (C) for static shear analysis

a. Earthquake Load (TEQ) in Transverse Direction
With Ttrans = 0.39,
then the value of C = 0.13 is obtained
TEQ = 0.15 x 1.0 x 1.225 x 1383.37 tons
= 220,3 ton

b. Earthquake Load (TEQ) in Longitudinal Direction
With Tlong = 0.68,
then the value of C = 0.18 is obtained
TEQ = 0.15x 1.0 x 1,225 x 1383.37 tons
= 305 ton.

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Output The reaction forces generated based on the input loading acting on the construction are presented in the table below:

Table 2. Reaction Style Resume

			GAYA REAKSI (Output SAP 2000)				
				H (t)		Momen (tm)	
NO	URAIAN	ID	V (t)	Arah x	Arah y	Arah x	Arah y
1	Beban Tetap						
a	Beban Mati	DL	413,35				
b	Beban Hidup	LL	200,47				
2	Aksi Lingkungan						
a	Beban Angin	TEW			-8,09	64,83	
b	Beban Gempa	TEQTRANS			-0,61	5	
		TEQ LONG		-41,86			-465,34
	Jumlah		613,82	-41,86	-9,07	69,83	-465,34

Recapitulation of Loads below:

a) Total Vertical Force Working
   ∑V = Vertical Load (SAP) + Additional Dead Load
   ∑V = 613,82 + 414,72 = 1028,54 ton
b) Horizontal Force
   Hx = -41,86 ton
   Hy = -9,07 tons
c) Momen Style
   Mx = 69,83 tonsm
   My = -465,34 tonsm

Table 3. Recapitulation of vertical and horizontal bearing capacity calculations

Vertikal					Horizontal		
Tunggal				Group	Tunggal		Group
Qujung (ton)	QSelimut (ton)	Qultimate (ton)	Qizin (ton)	Qg izin (ton)	Qultimate (ton)	Qizin (ton)	Qg izin (ton)
329,55	50,99	380,54	126,85	1745,39	25,92	8,64	138,24

Based on the calculation results, the amount of vertical force that can be accepted by the foundation of Pier P1 Sta 8 + 442 of the Depok - Antasari Section II Toll Road Project is 1745.39 tons. Meanwhile, the horizontal force that can be accepted by the foundation of Pier P1 Sta 8 + 442 of the Depok - Antasari Section II Toll Road Project is 138.24 tons.

3.4 Settlement

Decrease settlement calculation using metode *vesic* :

a) Derating due to deformation of single pile action
   L = length of poles buried in the ground = 12.00 m

Ap = pile tip area = 0.283 m2

Ep = modulus of elasticity of the pile
   = 33167848,00 kN/m2

α = 0,67

$$Ss = \frac{(Q_p + \alpha . Q_s).L}{A_p . E_p}$$

$$Ss = \frac{(707,00kN + 0,67.109,4kN).12,00m}{0,283m^2 . 33167848,00\,kN/m^2}$$

Ss = 0,0002m = 0,020 cm

b) Drop from the Tip of the Pole

Cp = 0,005
qp = 3295,51 kN/m2
Qp = 707,00 kN
D= 0,6 m

$$Sp = \frac{C_p.Q_p}{D.q_p}$$

$$Sp = \frac{0,05.707,00kN}{0,6m..3295,51\,kN/m^2}$$

Sp = 0,01788 m
Sp = 1,788 cm

Derating due to Loads Transferred Along the Mast

Qs = 109,4 kN
p = 1,884 m
L = 12,00 m
Es = 12500 kN/m2
vs = 0,2
Iws = 3,565

$$Sps = \left(\frac{Q_s}{p.L}\right).\frac{D}{E_s}.\left(1-v_s^2\right).I_{ws}$$

$$Sps = \left(\frac{109,4kN}{1,884m.12,00m}\right).\frac{0,6m}{12500\,kN/m^2}.\left(1-0,6^2\right).3,565$$

Sps = 0,0008 m

Sps = 0,08 cm

Based on the reduction in pile deformation, the ends of the pile and the load evenly distributed along the pile, a value for immediate settlement can be obtained:

Se = Ss + Sp + Sps
Se = (0,02+1,78 +0,08)cm
Se = 1,89cm

Based on the calculation results, an immediate reduction for single pile Pier P1 on the Depok - Antasari Highway (Section II) is 1.89 cm..

$$Sg = S\sqrt{\frac{B_g}{D}}$$

$$Sg = 0,0189m\sqrt{\frac{6,7m}{0,6m}}$$

Sg = 0,0631 m = 6,31 cm

Based on the calculation results, an immediate reduction for the Pier P1 pile group on the Depok - Antasari Highway (Section II) is 6.31 cm..

e) Consolidation Decline

ΔH = 1
E o = 2,2
P ‘c = 79
P ‘o = 58
Δp = 21
Cr = 0,046
Cc = 0,72

$$Sc = \left[\frac{0,046x1}{1+2,2}xlog\left(\frac{58+21}{58}\right)\right]$$

= 0,030 m
= 3,00 cm

f) Decreased Permit
Derivation of Permits based on (A.W & Macdonald, 1955) ie:

Table 4. Limits for Decreasing the Skempton and Macdonald Licenses 1955

Jenis Pondasi	Batas Penurunan Maksimum (mm)
Pondasi terpisah pada tanah lempung	65
Pondasi terpisah pada tanah pasir	40
Pondasi rakit pada tanah lempung	65-100
Pondasi rakit pada tanah pasir	40-65

Sumber : Hardiyatmo, H. C, 2002, *Teknik Pondasi I*, Penerbit PT. Beta Offset, Yogyakarta.

The maximum allowable drop is 10 cm, so based on the total value of the decline that occurs is 9.31 cm (6.31 cm + 3 cm) the foundation used is still safe.

3.5. Comparison between the Carrying Capacity of the Plan and the results of the PDA Test

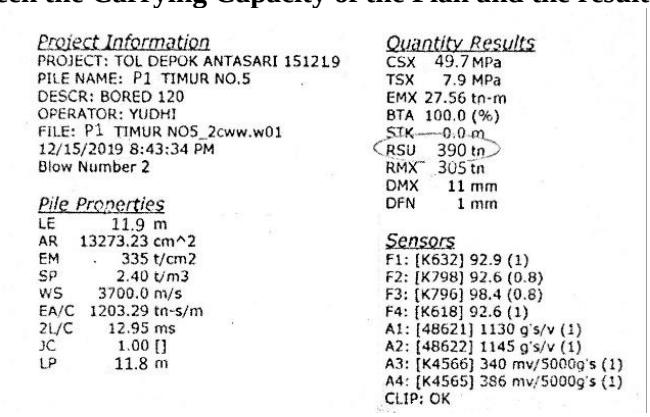

Figure 4. PDA Test result data in the field

Based on the results of the PDA Test above, it can be compared with the results of the calculation of the carrying capacity of the plan, shown in Table 4.3 below:

Table 5. Recapitulation of Comparison of Carrying Capacity Plan with Supporting Data of PDA Test Results

Daya Dukung Vertikal (Rencana)	**Tunggal**	Q_{ujung}	329,55 Ton
		$Q_{selimut}$	50,99 Ton
		$Q_{ultimit}$	380,54 Ton
		Q_{izin}	126,85 Ton
	Group	$Q_{g\,izin}$	1745,39 Ton
Daya Dukung Horizontal (Rencana)	**Tunggal**	$Q_{tunggal}$	25,92 Ton
		Q_{izin}	8,64 Ton
	Group	$Q_{g\,izin}$	138,24 Ton
Daya Dukung Vertikal (Hasil *PDA Test)*	Tunggal	$Q_{ultimit}$	390 Ton

It can be seen in table 4.3 that the carrying capacity of the plan is still safe, namely 380.54 tons below the maximum value of carrying capacity with the PDA Test 390 tons.

4. Conclussion

The following are the conclusions of the Bored Pile Foundation Planning Analysis at Pier P1 STA 8 + 442 at the Depok - Antasari Toll Road Project Section II:

1. Based on the calculation of the loading that works on the upper structure of Pier P1 STA 8 + 442 in the Depok - Antasari Toll Road Project Section II, namely structural dead loading, additional dead loading, wind load and vehicle earthquake load with the total reaction value:
   Vertical force = 1028,54 tons
   Maximum horizontal force = 41,86 tons
   Maximum moment force = 465,34 tonm
2. Based on the results of the calculation of the vertical bearing capacity and horizontal bearing capacity of the bored pile pier foundation P1 STA 8 + 442 In the Depok - Antasari Toll Road Project Section II, the vertical bearing capacity is 1745.39 tons and the horizontal bearing capacity is 138.24 tons, based on calculations the carrying capacity obtained from the bored pile foundation dimensions 6700 mm x 6700 mm and the number of foundation piles for 1 pile cap is 16 points.
3. Based on the comparison of the vertical bearing capacity with the vertical force and the horizontal bearing capacity with the maximum horizontal force, the bored pile foundation is able to withstand vertical forces (vertical bearing capacity = 1745.39 tonnes is greater than vertical force = 1028.54 tonnes) and horizontal forces (bearing capacity horizontally = 138.24 tonnes greater than the maximum horizontal force = 41.86 tonnes). The results of these calculations are still safe
4. Based on the results of the calculation of the reduction in the foundation of the bored pile pier P1 STA 8 + 442 In the Depok - Antasari Toll Road Project Section II, it was found that the amount of immediate decline that occurred was 6.31 cm deep and the consolidation decline was 3.00 cm so that the total foundation settlement was 9.31 cm is still below the allowable drop of 10.00 cm.
5. Based on the results of the PDA Test, it was obtained Ru 390 tons for 1 pile and the ultimate vertical bearing capacity of the single pile analyzed obtained 380.54 tons

5.Suggestion

Suggestions for research on titles related to Bored Pile Foundation Planning Analysis at Pier P1 STA 8 + 442 in the Depok - Antasari Toll Road Project Section II further, namely:

1. For further research, it is necessary to pay attention to supporting the planning data analysis on the load of the toll laying road plan required loading test data.
2. To find the lateral bearing capacity, it is expected to use Lpile or Plaxis 3D programs.

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The Effect of Plastic Pellet Substitution on Fine Aggregate and Gypsum Waste Substitution in Cement on the Compressive Strength of Lightweight Concrete

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ABSTRACT

Concrete is an important constituent material in a construction, concrete also has the constituent materials such as cement, aggregate, and water. However, the use of such compound materials can make an impact on health and environment, as cement production can produce CO2 emission gases, and the aggregate use resulting from mining activities can damage the environment in a long period of time. The experimental method, which is ways to reveal the causal relationship between two or more variables through careful experiments. These two forms are: exploratory experiments (aimed at the problem and hypothesis) and development experiments (aimed at proving hypotheses to make common generalizations.. Results of the test that has been conducted that strong press concrete on the 7th day with a strong result of the highest press obtained from a variation D of 9.76 MPa with a mixture of plastic seeds 0.6% and the waste of the 10%. Results of tests that have been conducted that strong press concrete on the 14th and 21st days with strong results of the highest press obtained at a variation of C amounted to 5.10 MPa on the 14th and 5.25 MPa on the 21st day with a mixture of 0.6% plastic seeds and a 5% waste of the range. The result of the test has been conducted that strong press concrete on the 28th day with a strong result of the highest press obtained from A Variation of 12.43 MPa with a mixture of 0.5% plastic seeds and a 5% of the waste of the. For the results of the overall variation that meets the quality of concrete with a target of K-125 on the 28th day of the variation A of 12.43 MPa, variation B of 10.60 MPa, C Variation of 11.32 MPa, D Variation of 10.21 MPa.

Keywords :
Gypsum Waste Compressive Strength, Lightweight Concrete, Plastic Seed.

1. Introduction

Concrete is one of the constituent elements of most vital buildings ranging from the column, brick, paving until the road is made of concrete so that the use of concrete tends to be high. Concrete is often used as the main buffer material in a building then it takes good quality (Prayogo et al., 2019).

In some types of concrete, we recognize the presence of mild concrete. Light concrete is a concrete that is generally made of mild aggregates, where this lightweight aggregate is the aggregate with a maximum weight dry oven dried contents of 1100 kg/cm3. The weight of light concrete content ranges between 1360-1840 kg/cm3 and can be regarded as a boundary of the actual lightweight concrete, although its value sometimes exceeds (Siswoyo et al., 2017).

Concrete has its constituent materials, cement, aggregate, and water. However, in certain conditions requires another enhancer that is additive/admixture so that the concrete can be optimal. Cement, aggregate, and water are concrete constituent materials that can be obtained from nature by mined. If it is continuously needed, do not cover the possibility if the natural resources can be depleted even during a long period of time.

Now time time researchers have done various kinds of research with the aim of finding alternative materials to be used substitute elements in the concrete, one of which is to do the substitution or arguably mixing concrete constituent materials with other materials, such as mixing wood powder waste with fine aggregate or a mixture of plastic waste as a substitute for abrasive aggregate material.

Plastic has a difficult to decompose properties where plastic takes hundreds of years to be able to decompose perfectly (Teressa, 2017), there are some researchers who have already done research on plastic utilization subtitution such as (Kusuma, 2019) "has researched that the maximum strong press rate occurs in the plastic composition of 0.4% at 11.91 MPa with an increase of 27.1% compared with the , (Supratikno & Ratnanik, 2019) "has researched that the most excellent mix portion is in processed aggregate plastic waste by 25% with a strong press of 10.14 MPa. Use of concrete structures that direct contact with sulfuric acid compounds will affect the strong quality of concrete press Karna sulfuric acid can make concrete into corrosion (Suhana & Asmayanti, 2015). Corrosion has been known for a long time and very harmful. The word corrosion is derived from the Latin corrodere which means metal destroyer or rusty (Supardi, 1997).

According to Hardjito (2007) cement production technology in Indonesia tends to wasteful energy and cause CO2 emissions to contribute to global temperature rise. In connection with this, it is done research as an effort to find other sources as an alternative ingredient of cement substitute, in this case one of the alternative materials that can be used is the waste of the material obtained from industrial waste or construction so that it can be utilized into cement subtitution material.

Based on the results of the explanation above then, the research is titled "Influence of Plastic grain subtitution on fine aggregate and the substitution of the waste of the the plant in cement to strong concrete press".

2. Metodologi

The method of research is how to know something to find, develop or test the truth systematically, logically and empirically using scientific methods. Surahman, (2016), so in this research the authors will use the experimental method, which is to use ways to reveal causal relationships due to two or more variables through careful experiments.

At this time the sand is used for the mixture of concrete manufacture derived from Cimangkok, gravel derived from cigudeg, cement used cement type I, plastic seed used in the Polyproplane, the waste is derived from the waste of the home industry is taken in the region Cibinong. This research is conducted by using Mix Design which refers to the national standard that is SNI 03-2834-2000.

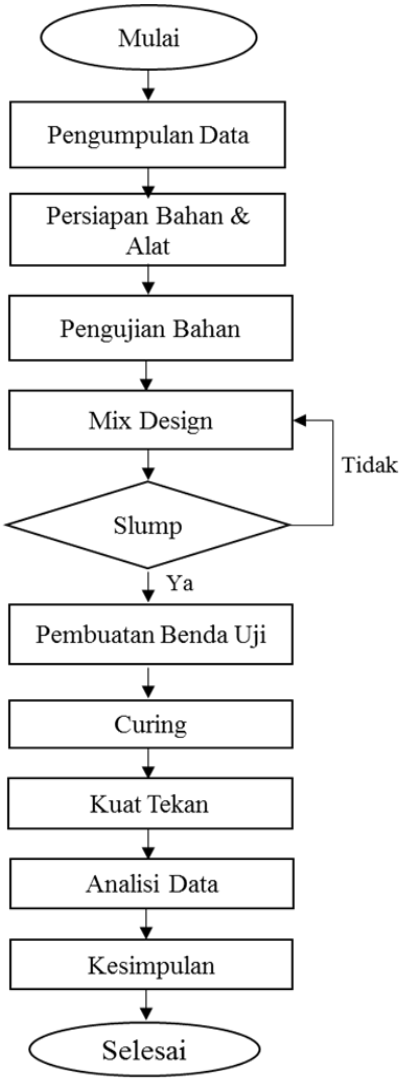


Figure 1. Flowchart
Source: Processed researchers

In the early stages of the study began with preparing the tools and materials to be used. For the next stage of preparation of tools that will be used in the laboratory is ensured in good condition and calibration has been done before, after the stage of preparation of the tool is completed carried out further testing on the matrial

material that will be used and continued with the planning of the calculation of mix design using Microsoft Excel software with calculations referring to SNI 03-2834-2000. Then do a trial mix and slump test. If the value of the slump test is in accordance with the planned then done concrete grafts using a cube diameter 15x15x15 cm. After the age of concrete for 24 hours, concrete will be opened from the mold and continued by curing the Eudora into a tub containing water. In this process concrete samples will be in the soak for 7, 14, 21, 28 days before the test carried out a strong concrete press, after the life of concrete is reached then concrete will be removed from the tub and then will begin a strong testing concrete press and will be obtained the strong data press its.

a. Cement that will be used in this research is the cement Jakarta weighing 40 kg/zak where cement is a Portland cement type I.
b. Sand Sands used in this research came from Cimangkok area.
c. gravel that will be used in this study obtained from Cigudeg.
d. The plastic beans used in this research use Polyproplane type (PP).
e. The waste of the plant used in this research is derived from industrial waste in the area of Cibinong.
f. Water used in this study is a water in the laboratory.

Table 1. Material needs to make 1 M3 of concrete

Materials	Kg/m^3
Cemen	375
Water	225
Fine aggregate	787
Gross aggregate	961

Place and Time

1. Place : This research will be conducted in the laboratory Wika Concrete Rapid train Jakarta-Bandung Plan Halim.
2. Time : This research will begin from June to July 2020.

3. Results and Discussion

3.1. Results of Plastic Seed Gradation Analysis

The following is the result of plastic grain gradation analysis with fineness modulus of 7.00.

Table 2. the result of plastic grain gradation analysis

Berat Bahan Kering : 500,0 gr

Saringan	Berat Tertahan (gram)	Jumlah Berat Tertahan	Jumlah Persen	
			Tertahan	Lewat
No. 4	0,00	0,00	0,00	100,00
No. 8	500,00	500,00	100,00	0,00
No. 10	0,00	500,00	100,00	0,00
No. 12	0,00	500,00	100,00	0,00
No. 20	0,00	500,00	100,00	0,00
No. 40	0,00	500,00	100,00	0,00
No. 80	0,00	500,00	100,00	0,00
No. 100	0,00	500,00	100,00	0,00
No. 200	0,00	500,00	100,00	0,00
PAN	0,00	500,00	100,00	0,00

FM = 7,00

3.2. Results of The Waste Gradation

Here are the results of the gradation of the waste of the, the fineness modulus 3.44.

Table 3. Results of the waste gradation

Berat Bahan Kering : 500 gr

Saringan		Berat Tertahan (gram)	Jumlah Berat Tertahan	Jumlah Persen	
				Tertahan	Lewat
9.52	(3/8")	-	-	0,00	100,00
No.	4	10	10,00	2,00	98,00
No.	8	60,00	70,00	14,00	86,00
No.	10	40,00	110,00	22,00	78,00
No.	12	30,00	140,00	28,00	72,00
No.	20	90,00	230,00	46,00	54,00
No.	40	80,00	310,00	62,00	38,00
No.	80	90,00	400,00	80,00	20,00
No.	100	50,00	450,00	90,00	10,00
No.	200	30,00	480,00	96,00	4,00
PAN		20,00	500,00	100,00	0,00

Fineness Modulus 3,44

3.3. Results of Slump Test Scores

Here is the results of the slump test.

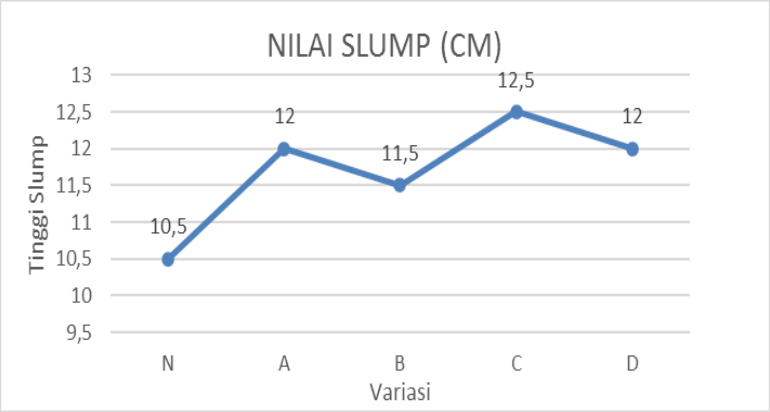
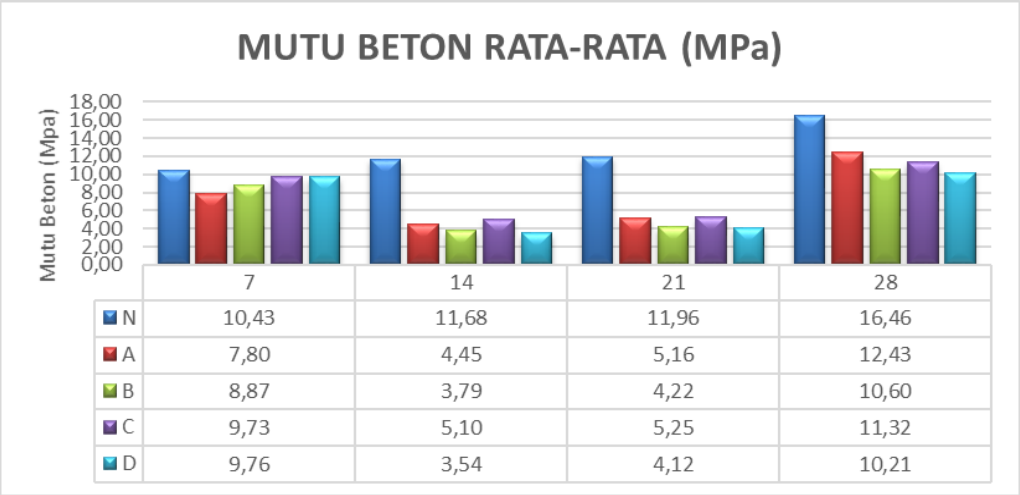


Figure 2. the results of the slump test

From the results of the slump test above with a target of 10 ± 2 cm, it is obtained the normal concrete value (N) of 10.5 cm, concrete with a variation of plastic beans 0.5% + The waste of A 5% (A) of 12 cm, concrete with a variation of plastic seeds 0, 5% + waste of a 10% (B), 11.5 cm, concrete with a variation of plastic beans 0.6% + waste of a 5% (C) of the amount of 12.5 cm, concrete with a variation of plastic beans 0.6% + waste of a 10% (D) of 12 cm.

3.4. Strong Concrete Press Test Result

Here are the results of strong concrete press testing:



	7	14	21	28
N	10,43	11,68	11,96	16,46
A	7,80	4,45	5,16	12,43
B	8,87	3,79	4,22	10,60
C	9,73	5,10	5,25	11,32
D	9,76	3,54	4,12	10,21

Figure 3. The results of strong concrete press testing

From the data of strong test result press overall variation then it is known that the highest press strong on the 7th day is a variation D with a mixture of 0.6% plastic seeds and the waste of the 10% of the range with strong press of 9.76 MPa, For Strong press highs on the 14th and 21st days is a variation of C with a mixture of 0.6 plastic seeds and a 5% of the waste of the of the-5.25 5.10 , for the highest strong press on the 28th day is a variation A with a mixture of 0.5% plastic seeds and the waste of the 5% of the range, for the overall results of the variation that meets the quality of concrete with the target K-125 is present on the 28th day is a variation of 12.43 MPa, variation B of 10.60 MPa, variation C of 11.32 Mpa.

4. Conclusion

a. The use of plastic beans are closed with a fine aggregate and the use of the waste of the power in the substitution with cement can be strong press.
b. Results from the tests that have been conducted that strong press concrete on the 7th day with a strong result of the highest press obtained from a variation of D 9.76 MPa with a mixture of 0.6% plastic seeds and a 10% of the waste of the.
c. Results of tests that have been conducted that strong press concrete on the 14th and 21st days with strong results of the highest press obtained at a variation of C amounted to 5.10 MPa on the 14th and 5.25 MPa on the 21st day with a mixture of 0.6% plastic seeds and a 5% waste of the range.
d. Results of the test that has been conducted that strong press concrete on the 28th day with a strong result of the highest press obtained from A Variation of 12.43 MPa with a mixture of plastic seeds 0.5% and the waste of A 5%.
e. For the overall results of the variation that meets the quality of concrete with the target of K-125 on the 28th day of variation A of 12.43 MPa, variation B of 10.60 MPa, C Variation of 11.32 MPa, D Variation of 10.21 Mpa.

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Biografi

Muhammad Galuh Firdaus is a student of the University of Mercubuana Bekasi with a civil Engineering study program. Before majoring in civil engineering, at the previous level of SMK Negeri 1 Cibinong, with the Department of Image Engineering, the author graduated from SMKN in 2015 then immediately went to study at the Bandung State Polytechnic in 2015, during the lecture of active writers as a member of the association. In the year 2017 the writer continued his education at the University of Mercu Buana Bekasi majoring in civil engineering, during the lecture of the writers once participated in the seminar event as a division of events. With this research the authors hope research can become something of learning and hope for the next study is well developed.

Agyanatha Tua Munthe was a lecturer from the University of Mercubuana Bekasi, Mr. Agyanatha had studied at Universitas Atmajaya Yogyakarta, majoring in civil engineering and graduated in the year 2004 with a bachelor degree in engineering. The father of Agyanatha continued his studies at the Gadjah Mada University in Yogyakarta, majoring in civil engineering and graduated in 2006 with the title of technical magisterial. In the years 2007 – 2010 Mr. Agyanatha worked at PT. INDALEX (MASPION GROUP) and served as a site engineer. PT. DUTA SARANA PERKASA (Dusaspun) in 2010 – 2013 served as Technical Sales Engineer M-System, PT CIPTA MORTAR UTAMA (CMU) in 2013 March-2013 December served as the wife. Manager of Technical External Development, then in 2014 – 2016 served as Jr. Manager Product Management. PT BOSTIK INDONESIA in 2016 – 2017 served as Senior Technical Consultant and Support Sales. PT. MASJAYA SEJAHTERA in 2017 until now serves as Project Manager.

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Analysis of Cost and Quality Comparison of Recycling Project Fence (RFP) with Zincalume Project Fence (Case Study Project X in Jakarta)

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Abstract

The fence of the project is a fence established on the project land for the safety boundary of the project during the period of implementation of the project, according to The Perda Dki No.7 Year 1991 the fence of the project should pay attention to the safety and harmony of the surroundings and have a height of at least 2.5 meters. The cost of installing a project fence requires a relatively high cost on a project that has a long perimeter area. Project Fence usually uses zincalume material and is often a problem of construction waste because the material is not durable, this led to the innovation of Recycling Project Fence (RFP). In this study, the authors conducted a cost and quality comparison between the two materials by conducting cost analysis in accordance with the contractor's cost analysis and disseminating 2 stages of questionnaires on quality comparison to experts and respondents who are contractor employees who are accustomed to using RFP. The results of the questionnaire will be conducted to test validity and reliability using statistical software and analysis of relative importance index (RII). The result of this study is the total cost required for PPDU Rp.1,097,864,515 and the total cost required for fencing the zincalume project Rp. 980,546,545 where PPDU is more expensive Rp. 117,317,979 or 10.69%. with the most influential variables on the comparison of RFP quality with Zincalume are Features (0.860), Durability (0.851), Aesthetics (0.850), Performance (0.823), Reliability (0.693). So that the cost of fencing zincalume project is more effective while ppdu quality is more effective to use.

Keyword :
Comparison, Cost, Quality, Recycling Fence Project (RFP), Zincalume.

1. Introduction

The fence of the project is a fence established on the project land for the safety boundary of the project during the period of implementation of the project. In general, the fence of the project uses zincalume material but as infrastructure development in Indonesia increases zincalume project fence becomes a new problem because the material is not durable, so it can no longer be used in the next project and become construction waste at the end of the project construction period. construction waste can have a negative effect on the environment around the project construction site. Along with the problem of construction waste, causing the emergence of new innovations such as materials and supporting equipment that can be used more than once and can be recycled, for example such as the use of Recycling Project Fences (RFP).

According to DKI Regulation No.7 year 1991 article 233 the project fence should pay attention to the safety and harmony of the surrounding area and have a height of at least 2.5 meters, under certain conditions the cost of installing the project fence requires a fairly high cost especially on projects with a long perimeter area.

The purpose of this research is to find out how cost and quality compare between recycling project fences and find out if RFP is efficient enough to replace zincalume project fences.

2. Reference

Cost and Quality are important enough in a construction project, so good management needs to be done so that the objectives of the project implementation can be met

2.1. Project Cost budget Plant

The Project Cost Budget Plan is an estimate of the cost required for each work in a construction project so that the total cost will be obtained to complete a project. In the calculation of project cost estimation there are two types of cost grouping, namely direct cost and indirect cost.

2.2. product Quality

The quality of the product is the factors contained in an item or result that cause the goods or results to be in accordance with the purpose for which the goods or results are intended.

The product quality indicators according to (Tjiptono, 2001) are:

1. Performance is the main operating characteristic of this purchased product. E.g. speed, ease and convenience in use
2. Aesthetics that is the attractiveness of products to the five senses, e.g. physical shape, artistic model or design, color and so on
3. Realibility is less likely to be damaged or failed to use. E.g. quality and design oversight, operational characteristic standards of conformity to specifications
4. Durability which means durability shows the age of the product, i.e. the durability of the product can be used, the longer the durability the more durable, durable products will be perceived to be more quality than products that are quickly depleted or quickly replaced
5. Features that are additional characteristics or features that complement the basic benefits of a product. Features can improve product quality if competitors don't have them.

2.3. Zincalume Project Fence

The project fence is made of zincalume material with hollow frame. In general this material is used as a roof cover but this material is used as a project fence because the material is easy to obtain and light.

Figure 1. Zincalume Project Fence
Source: google image, 2020

2.4. Recycling Project Fence (RFP)

This project fence is made of poly vinyl clorida main material with calcium carbonate mixture as material for strength and reinforcing agent and stabilizer to make RFP not easily broken and fireretardant.

Figure 2. Recycling Project Fence (RFP)
Source: erom abadi, 2020

3. Methodology

Cost analysis is done by looking for the price per square meter by previously determining the coefficient, material unit price, and wage. Further multiplication is done between the volume of work and the unit price.

$$\text{Cost Budget Plan} = \sum [(\text{volume}) \times \text{Unit Price}]$$

To determine the number of respondents using the slovin formula:

$$n = \left(\frac{N}{1+N\,(e)^2} \right)$$

Figure 3. the slovin formula

Where :
n = sample
N = Population
e = percentage of tolerated errors, e = 10%

The results of the questionnaire data obtained are done validity and reality test with the next test of Relative Importance Index (RII) with the following formula:

$$Relative\ Imporatance\ Index = \frac{5.n5 + 4.n4 + 3.n3 + 2.n2 + 1.n1}{5.N}$$

Description :
n5 = Number of Respondents who responded with 5 points
n4 = Number of Respondents who responded with 4 points
n3 = Number of Respondents who responded with 3 points
n2 = Number of Respondents who responded with 2 points
n1 = Number of Respondents who responded with 1 points
N = Number of respondents

4. Analysis and discussion

4.1. cost analysis

In the unit price analysis there are several parts that need to be considered including, the coefficient of material needs, the price of materials, the coefficient of wages and the cost of wages in the areas reviewed.

4.1.1 Direct Cost Analysis

Table 1. Direct Cost Analysis RFP per m2

No.	Description	unit	Coeff.	Unit Price (Rp.)	Total (Rp.)
1	Panel RFP	m2	1.00	120,000.00	120,000.00
2	Frame	m'	2.11	17,500.00	36,944.44
3	Joiner (clamp)	unit	2.00	10,000.00	20,000.00
				TOTAL MATERIAL	176,944.44
No.	Description	unit	Coeff.	Unit Price (Rp.)	Total (Rp.)
1	workers	OH	0.40	138,077.00	55,230.80
2	Builders	OH	0.20	158,789.00	31,757.80
3	Head of builders	OH	0.02	173,978.00	3,479.56
4	Foreman	OH	0.02	185,023.00	3,700.46
				TOTAL WAGE	94,168.62
				TOTAL DIRECT COST	271,113.06

Source: Processed author, 2020

Table 2. Direct Cost Analysis Zincalume Project Fence per m2

No.	Description	unit	Coeff.	Unit Price (Rp.)	Total (Rp.)
1	Zincalume	m2	1.00	106,000.00	120,000.00
2	frame	m'	2.11	17,500.00	36,944.44
3	Joiner (screw)	unit	5.00	644.00	3,220.00
				TOTAL MATERIAL	146,164.44
No.	Description	unit	Coeff.	Unit Price (Rp.)	Total (Rp.)
1	Pekerja	OH	0.40	138,077.00	55,230.80
2	Tukang	OH	0.20	158,789.00	31,757.80
3	Kepala Tukang	OH	0.02	173,978.00	3,479.56
4	Mandor	OH	0.02	185,023.00	3,700.46
				TOTAL WAGE	94,168.62
				TOTAL DIRECT COST	240,333.06

Source: Processed Author, 2020

4.1.2 Indirect Cost Analysis

Table 3. Indirect Cost Anallysis

No	Description	Vol.	unit	Unit Price (Rp.)	Total (Rp.)
1	Mobilization Materials & Tools	1	ls	11,100,000	11,100,000
2	Material impairment charges	1	ls	7,643,382	7,643,382
3	Supervisor and field accommodation (electricity)	1	ls	16,000,000	16,000,000
4	Risk cost reserves	1	ls	23,908,500	23,908,500
	Total Indirect Cost				58,651,882
	Volume				3465 m2
	Indirect Cost per m2				16,926

Source: Processed Author, 2020

4.1.3 Total Cost Analysis

Table 4. Total Cost Analysis RFP

NO	Description	VOL	unit	TOTAL (Rp.)
1	Direct Cost	1	m2	271,113
2	Indirect Cost	1	m2	16,926
			Total	288,040
			Profit 10%	28,804
			Grand Total	Rp. 316,844

Source: Processed Author, 2020

Table 5. Total Cost Analysis Zincalume Project Fence

NO	DESCRIPTION	VOL	UNIT	TOTAL (Rp.)
1	Biaya Langsung	1	m2	240,333
2	Biaya Tak Langsung	1	m2	16,926
			Total	257,260
			Profit 10%	25,726
			Grand Total	Rp. 282,986

Source: Processed Author, 2020

Table 6. Total Cost RFP

RFP			
Volume	unit	Unit Price	Total
3465	m2	Rp. 316,844	Rp. 1,097,864,515

Source: Processed Author, 2020

Table 7. Total Cost Zincalume Project Fence

Zincalume			
Volume	unit	Unit Price	Total
3465	m2	Rp. 282,986	Rp. 980,546,545

Source: Processed Author, 2020

Based on a table of 7 costs required for the installation of recycling project fences amounting to Rp. 1,097,864,515,- and for zincalume project fencing of Rp. 980,546,545,- where RFP is more expensive Rp. 117,317,970,- compared to zincalume project fence.

4.2.Quality Comparison Analysis

4.2.1 Distribution of respondents

Table 8. Distribution of respondents' education levels

No.	Education Level	Amount	Precentage
1	S1	26	87 %
2	SMA	4	13 %
	Total	30	100%

Source: Processed Author, 2020

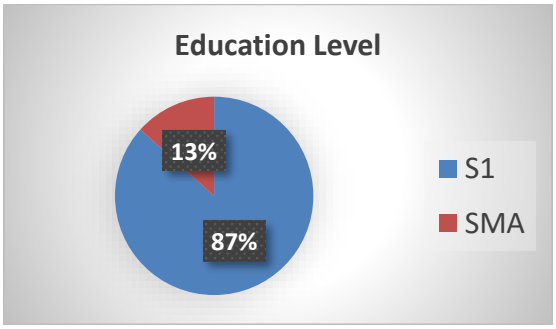

Figure 4. Distribution of respondents
Source: Processed Author, 2020

Table 9. Distribution of respondents' work experience

No.	Work Experience	Amount	Precentage
1	<5 years	5	17 %
2	5-10 years	21	70 %
2	>10 years	4	13 %
	Total	30	100%

Source: Processed Author, 2020

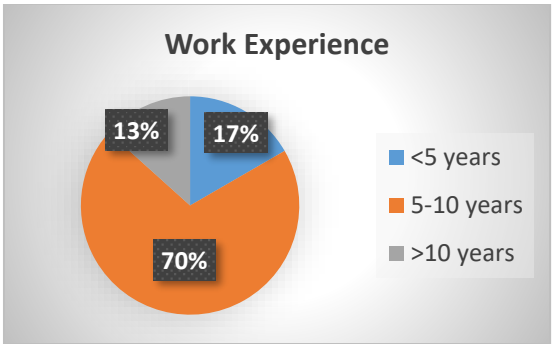

Figure 5. Distribution of respondents
Source: Processed Author, 2020

4.2.2 Validity test

Table 10. Validity Test Recapitulation

VALIDITY			
No. Item	rhitung	rtabel 5% (30)	Description
X1.1	0.927	0.361	Valid
X1.2	0.822	0.361	Valid
X2.1	0.915	0.361	Valid
X2.2	0.919	0.361	Valid
X3.1	0.604	0.361	Valid
X3.2	0.635	0.361	Valid
X3.3	0.784	0.361	Valid
X3.4	0.809	0.361	Valid
X4.1	0.804	0.361	Valid
X4.2	0.885	0.361	Valid
X4.3	0.678	0.361	Valid
X5.1	0.742	0.361	Valid
X5.2	0.696	0.361	Valid
X5.3	0.732	0.361	Valid
X5.4	0.791	0.361	Valid

Source: Processed Author, 2020

Based on table 10 indicators X.1.1 to X.5.4 are declared valid because the rhitung value is greater than rtabel. With the following interpretation :

1. Compare the value of rhitung with rtable
   a. If the value of rhitung > rtabel = Valid
   b. If the value of rhitung < rtabel = Invalid
2. See the value of signification (Sig.)
   a. If the value of Significance < 0,05 = Valid
   b. If the value of Siginficance > 0,05 = Invalid.

4.2.3 Realibility test

Table 11. Realibility test recapitulation

RELIABILITAS					
No. Item	Indicators	Alpha Cronbach Item	rtabel 5% (30)	Value Alpha Cronbach	Description
X.1	PERFORMANCE	0.820	0.361	0.60	REALIBEL
X.2	AESTHETIC	0.850	0.361	0.60	REALIBEL
X.3	REALIBILITY	0.693	0.361	0.60	REALIBEL
X.4	DURABILITY	0.851	0.361	0.60	REALIBEL
X.5	FEATURES	0.860	0.361	0.60	REALIBEL

Source: Processed Author, 2020

Based on table 11 all variables are declared ralibels because according to the interpretations i.e :

1. If the Cronbach Alpha > 0,60 the questionnaire is declared reliabel or consistent.
2. If the Cronbach Alpha < 0,60 then the questionnaire is declared un reliabel or inconsistent.

4.2.4 Relative Importance Index (RII)

Table 12. Indicators Ranking

Ranking		Indicators
1	X.5.3	RFP can be recycled so as to reduce construction waste problems
2	X.4.3	RFP has a longer service life than zincalume
3	X.5.4	RFP can be made soundproof by adding special materials
4	X.2.1	RFP has a more attractive look compared to zincalume
5	X.5.1	RFP does not require painting costs to beautify the display
6	X.3.2	RFP is neater in terms of appearance compared to zincalume
7	X.2.2	RFP is easier to install compared to zincalume
8	X.1.2	RFP is more resistant to weather such as rain/heat compared to zincalume
9	X.4.2	RFP is more impact resistant than zincalume
10	X.4.1	RFP has more module size than zincalume
11	X.1.1	RFP is faster installation than zincalume
12	X.5.2	RFP is safer and does not harm workers such as scratching parts of the fence that can cause injuries
13	X.3.1	RFP requires a lower maintenance fee compared to zincalume
14	X.1.3	RFP needs more manpower compared to zincalume
15	X.3.3	RFP material is lighter than ziincalume

Source: Processed Author, 2020

Table 13. Variabels Ranking

Ranking	Variabel	RII
1	Features (X5)	0.860
2	Durability (X4)	0.851
3	Aesthetic (X2)	0.850
4	Performance (X1)	0.820
5	Realibility (X3)	0.693

Source: Processed Author, 2020

Conclusion

From this study obtained the following conclusions:

1. The cost required for the work of installing recycling project fences is Rp. 316.844,- per m2 and the cost required for one area with a volume of 3465 m2 is Rp. 1,097,864,515, while the cost required for the construction of zincalume project fence is Rp. 282,986,- per m2 and the cost for one area with a volume of 3465 m2 is Rp. 980,546,545.
2. The price of recycling project fence compared to zincalume project fence is more expensive Rp. 33,858 per m2 or Rp. 117,317,970 for the volume of one area (3465 m2) or by percentage fencing recycling project is more expensive 10.69% compared to zincalume project fence
3. Based on the results of the recycling project fence questionnaire has better quality compared to zincalume project fence, with 5 most beaked variables with the following RII values: Features (0.860), Durability (0.851), Aesthetics (0.850), Performance (0.820), Reliability (0.693),
4. In this study can be summed up costly zincalume project fence is more effective to use, because the cost required is cheaper, while in terms of quality fence recycling project is more effective to use compared to zincalume project fence. This can be adjusted to the existing project conditions.

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Analysis of Road Performance and Vehicle Parking Characteristics in the Halim Perdanakusuma International Airport Area

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Abstract

The Corona virus that broke out around the Wuhan area in December has spread in 100 countries and caused more than 100,000 people worldwide to test positive for infection. The impact of this pandemic has caused countries to close access in and out to their respective countries, including Indonesia, which has caused threats to the economy, especially in the aviation sector. The aviation sector which was affected by the Covid-19 epidemic affected all sectors in it including airport operations, namely the parking revenue sector. The decrease in the number of aircraft use has an impact on the number of vehicles entering and exiting which results in a significant decrease in the parking revenue itself. Therefore, the purpose of this study is to determine the performance of roads and vehicle parking characteristics. The method used in this research is to conduct direct field surveys including parking accumulation, parking duration, parking lot capacity, road geometry, traffic volume, side friction and vehicle speed. The analysis results obtained that the parking characteristics for the highest accumulation of four-wheeled vehicles are 1038 vehicles and 329 vehicles for two-wheeled vehicles, parking duration ranges from <1 hour for cars and> 7 hours for motorbikes, the highest parking volume is 3578 cars and 1180 motorbikes, turnover rate parking lots on average 0.14 cars / plot and 0.04 motorbikes / parking lot. The average car index is 82.9% and 33.1% for motorbikes, so that vehicle parking at the airport still accommodates parking demand. The impact of the Covid-19 pandemic caused a decrease in vehicle volume by 91% for four-wheeled vehicles and 55.4% for two-wheeled vehicles. In terms of parking characteristics, vehicle parking at Halim Perdanakusuma International Airport can still accommodate requests. For the performance of the Angkas I Halim Perdanakusuma road section.

Keywords
Covid-19 Impact, Parking characteristics, Road Performance

1. Preliminary

1.1 Background

Corona virus or in its scientific designation is called Covid-19. The corona virus began to spread around the Wuhan area and has now infected more than 100 countries. A total of more than 100,000 people in the world tested positive for this virulent virus. Ministry of Transportation spokesperson Adita Irawati stated that the Covid-19 epidemic or the corona virus has reduced the occupancy rate of mass transportation such as planes.

Based on the above background, in this case it is necessary to analyze the characteristics of vehicle parking including parking accumulation, parking volume, parking duration and parking index in order to determine the provision of parking spaces and road performance to and from Halim Perdanaksuma International Airport, it is necessary to do research with the title "Analysis. Road Performance and Vehicle Parking Characteristics in the Area of Halim Perdanakusuma International Airport ".

2. Parking Characteristics

Analysis of parking characteristics is to determine the basic characteristics that provide an assessment of parking services and parking problems found in the study location. The analysis of parking characteristics includes parking accumulation, parking duration, parking volume, parking turnover rate and parking index. In addition, an analysis of the prediction of parking characteristics will be carried out for the next 5 years.

2.1 Parking Accumulation

Accumulation is the number of vehicles parked in a certain time period, usually per day (F. D. Hobbs, 1979). The unit of accumulation is the vehicle.

Accumulation = Qin - Qout + Qs
Information :
Qin = ∑ vehicles entering the parking location
Qout = ∑ vehicles exiting the parking location
Qs = ∑ vehicles that have been at the parking location before observations made

2.2 Parking Duration

Parking duration is information that is needed to determine the length of time a vehicle is parked.

Duration = tout - tin
Information
tout = time when the vehicle entered the parking location
tin = time when the vehicle exits the parking location

2.3 Parking Volume

Parking volume is the number of vehicles included in the parking load, namely the number of vehicles per certain time period, usually per day (F. D. Hobbs, 1979).

Volume = Nin + X (vehicle)
Information :
Nin = number of incoming vehicles (vehicles)
X = vehicles that already exist before the survey time

2.4 Parking Turnover Rate

The parakeet turnover rate is the amount of parking space used and is obtained by dividing the parking volume by the number of parking spaces for a given period. The amount of parking turnover is obtained from the equation:

Parking Turnover Rate = $\frac{Volume\ Parkir}{petak\ parkir\ tersedia}$

2.5 Parking Index

The parking index is a presentation of the accumulated number of vehicles at a certain time divided by the available parking space then multiplied by 100%.

IP = x 100%$\frac{Akumulasi}{petak\ parkir\ tersedia}$

3. Performance Of Road Space

Some of the parameters used in determining road performance are as follows:

3.1 Capacity

Capacity is the maximum traffic flow that can pass stably on a cross section of the road under certain conditions.

C = C0 x FCW x FCSP x FCSF x FCCS
Information :
C = Capacity real (pcu / hour)
CO = Basic capacity (pcu / hour)
FCW = Road width adjustment factor
FCSP = Directional separation adjustment factor (only for undivided roads)
FCSF = Side drag and shoulder / curb adjustment factor
FCCS = City size adjustment factor.

3.2 Degree of Saturation

The DS value indicates whether the road segment has a capacity problem or not. The equation is as follows:

DS = $\frac{Q}{C}$
Information :
DS = Degree of saturation
Q = Traffic flow (pcu / hour)
C = Capacity (pcu / hour)

3.3 Speed

MKJI uses travel speed as the main measure of road segment performance. The equation is as follows:

$V = \frac{L}{TT}$

Information :

V= Light vehicle average speed (km / h)

L = Length of segment (km)

TT = Average travel time of light vehicles along the segment (hours)

3.4 Service Level

The measure of the effectiveness of the level of service or level of service (LOS) is divided into six classes, namely from the best level of service A to level F for the worst conditions.

4. Methodology

Estimates of the provision or need for parking areas and road performance based on reliable data or information. The most important initial stage is to determine the survey objectives. In carrying out the survey, there is some information needed, such as the arrival pattern of traffic flows, fluctuations and congestion points, location capacity and characteristics of available facilities, the presence of signs and markers and parking processing and management (Spektran *et al.*, 2017).

Primary data recording was carried out using the parking system used by PT. Securindo Packatama Indonesia as the parking manager for Halim Perdanakusuma International Airport. Data regarding the number of vehicles that enter and leave are obtained from the recording by the system automatically. The system at each parking door will record the vehicle number through the vehicle doors that enter and leave each type of vehicle. the sum of vehicles entering and leaving the area will provide an overview of the accumulation of vehicles in the study area. The number of vehicles at a time can describe the parked vehicles and the total number of vehicle movements. by reducing the number of moving vehicles, the required number of parking spaces can be obtained.

The primary data survey was also carried out in the Halim Perdanakusuma I Street Area. The steps are taken by taking geometric data by measuring the length of the road segment under study then measuring the road width and shoulder width. Then, the traffic volume data were surveyed by determining the type of vehicle based on the classification. Side friction survey data is taken by observing and recording roadside activities. Vehicle speed is searched using a speed gun to compare the average speed of the vehicle with the maximum speed limit. All data is processed to obtain the level of service for the road.

5. Result and Discussion

5.1 Analysis of Parking Characteristics Data at Halim International Airport Perdanakusuma

5.1.1 Parking Volume

Parking volume is the number of vehicles in a certain time period, usually per day (F. D. Hobbs, 1979).

5.1.1.1 Parking Entry Volume

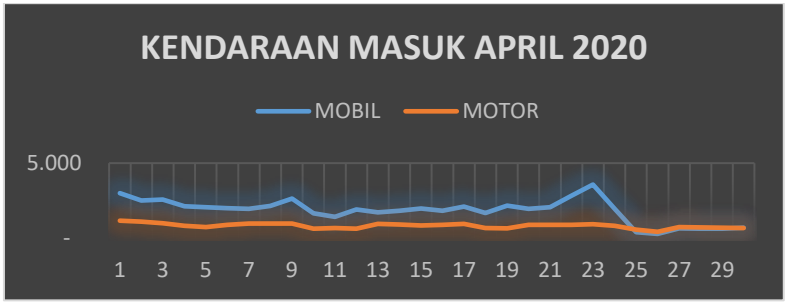


Figure 1. April 2020 Car and Motorcycle Entrance Parking Volume
Source: Survey results, April 2020

Based on the graph above, it is obtained that the maximum volume of parking for vehicles entering cars occurs on April 23, 2020 with a total volume of 3578 vehicles, while the maximum volume of vehicles entering motorbikes occurs on April 1, 2020 with a total volume of 1180 vehicles.

5.1.1.2 Parking Exit Volume

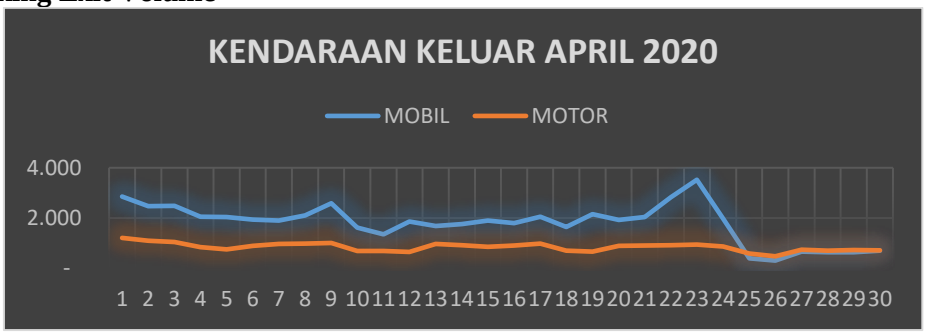
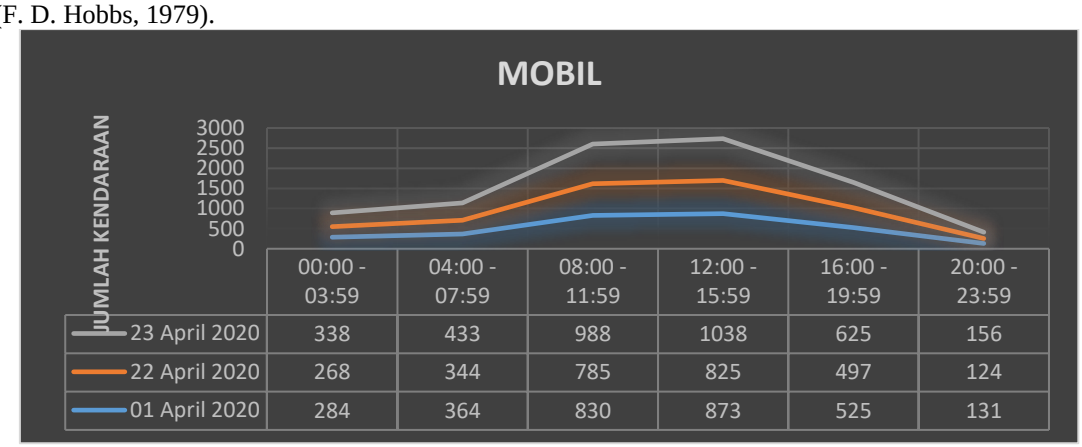


Figure 2. April 2020 Car and Motorcycle Entrance Parking Volume
Source: Survey results, April 2020

Based on the chart above, it is obtained that the maximum volume of vehicle parking for exiting cars occurred on April 23, 2020 with a total volume of 3522 vehicles, while the maximum volume of vehicles entering motorbikes occurred on April 1, 2020 with a total volume of 1206 vehicles.

5.1.2 Accumulated Parking

Parking accumulation is the number of parked vehicles in hours per a certain period of time, usually per day (F. D. Hobbs, 1979).

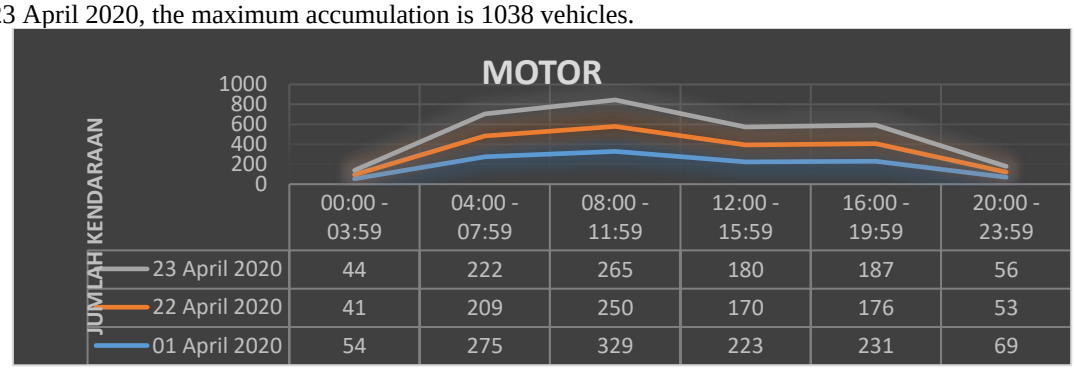


	00:00 - 03:59	04:00 - 07:59	08:00 - 11:59	12:00 - 15:59	16:00 - 19:59	20:00 - 23:59
23 April 2020	338	433	988	1038	625	156
22 April 2020	268	344	785	825	497	124
01 April 2020	284	364	830	873	525	131

Figure 3. Car Vehicle Accumulation Graph
Source: Survey results, April 2020

From the graph of the accumulation of parking at Halim Perdanakusuma International Airport for car vehicles, it is obtained:

1. April 1, 2020, the maximum accumulation is 873 vehicles.
2. April 22, 2020, the maximum accumulation is 825 vehicles.
3. 23 April 2020, the maximum accumulation is 1038 vehicles.



	00:00 - 03:59	04:00 - 07:59	08:00 - 11:59	12:00 - 15:59	16:00 - 19:59	20:00 - 23:59
23 April 2020	44	222	265	180	187	56
22 April 2020	41	209	250	170	176	53
01 April 2020	54	275	329	223	231	69

Figure 4. Motor Vehicle Accumulation Graph
Source: Survey results, April 2020

From the graph of the accumulation of parking at Halim Perdanakusuma International Airport for motorbikes, it is obtained:

1. April 1, 2020, the maximum accumulation is 329 vehicles.
2. April 22, 2020, the maximum accumulation is 250 vehicles.
3. April 23, 2020, accumulated a total of 265 vehicles.

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5.1.3 Parking Duration

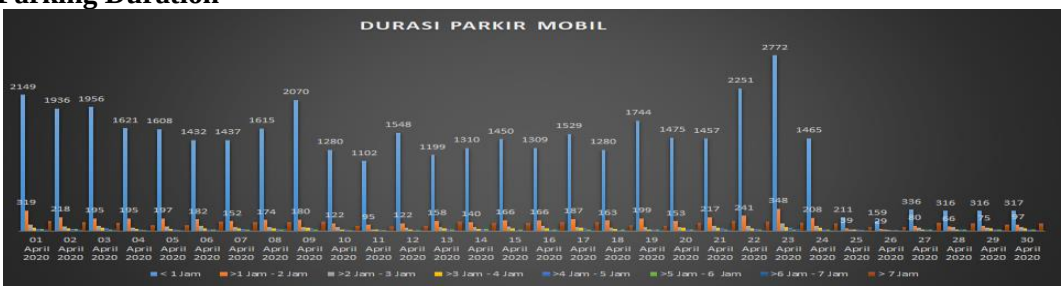

Figure 5. Car Parking Duration at Halim Perdanakusuma International Airport
Source: Survey results, April 2020

From the picture above, it is obtained that the time the vehicle uses the most car parking area at Halim Perdanakusuma International Airport, the highest is the time range 00:01 - 00:59 so it is included in short term parking.

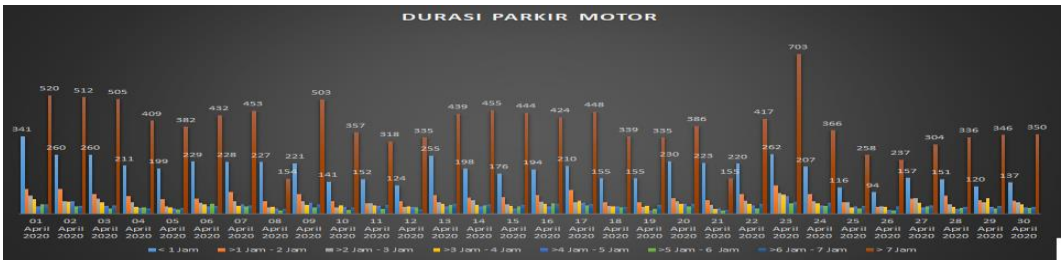

Figure 6. Motorcycle Parking Duration at Halim Perdanakusuma International Airport
Source: Survey results, April 2020

From the picture above, it is found that the time the vehicle uses the most motorbike parking area at Halim Perdanakusuma International Airport, the highest is the time range> 7 hours so it is included in long-term parking.

5.1.4 Parking Turn Over

Table 1. April 2020 Parking Turnover Rate

DATE	PARKING VOLUME / HOUR		TOTAL SPACE		TPP (times)	
	CAR	MOTORCYCLE	CAR	MOTORCYCLE	CAR	MOTORCYCLE
1	125	49			0.11	0.04
2	105	46			0.10	0.04
3	108	43			0.10	0.04
4	89	35			0.08	0.03
5	86	31			0.08	0.03
6	84	38			0.08	0.03
7	82	41			0.07	0.04
8	90	41			0.08	0.04
9	110	41			0.10	0.04
10	70	27			0.06	0.02
11	59	29			0.05	0.03
12	80	27			0.07	0.02
13	73	40			0.07	0.04
14	77	39			0.07	0.04
15	82	36	1100	850	0.07	0.03
16	76	38			0.07	0.03
17	88	40			0.08	0.04
18	71	29			0.06	0.03
19	90	28			0.08	0.03
20	82	38			0.07	0.03
21	86	37			0.08	0.03
22	118	37			0.11	0.03
23	149	40			0.14	0.04
24	82	35			0.07	0.03
25	17	24			0.02	0.02
26	13	19			0.01	0.02
27	28	32			0.03	0.03
28	27	30			0.02	0.03
29	27	30			0.02	0.03
30	30	29			0.03	0.03

Source: Survey results, April 2020

From the table above, it is found that the daily car turnover rate is 0.14 cars / parking lot on average. Meanwhile, the daily motorbike turnover rate is 0.04 motorbikes / parking lot on average.

5.1.5 Parking Index

Table 2. Vehicle Parking Index at Halim Perdanakusuma International Airport

Date	Time		Accumulated Parking		Total Space		Parking Index%	
	Car	Motorcycle	Car	Motorcycle	Car	Motorcycle	Car	Motorcycle
01 April 2020	12:00 - 15:59	08:00 - 11:59	873	329			79.4	38.7
22 April 2020	12:00 - 15:59	08:00 - 11:59	825	250	1100	850	75.0	29.4
23 April 2020	12:00 - 15:59	08:00 - 11:59	1038	265			94.4	31.2
			Average				82.9	33.1

Source: Survey results, April 2020

The average parking index at Halim Perdanakusuma International Airport is

1. For car parking by 82.9%
2. For parking of motor vehicles by 33.1%

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5.2 Analysis of Parking Characteristics for the Next Five Years at International Airports

Halim Perdanakusuma

Table 3. Prediction of incoming vehicles at Halim Perdanakusuma International Airport (r = -1.25% / car & r = -1.44% / motorbike)

Transportation type	Year				
	2020	2021	2022	2023	2024
Car	2,353,940	2,324,516	2,295,459	2,266,766	2,238,431
Motorcycle	402,971	397,169	391,449	3,858,125	380,257

Source: Survey results, April 2020

Table 4. Prediction of vehicles entering Halim Perdanakusuma International Airport (r = -1.25% / car & r = -1.44% / motorcycle)

Transportation type	Year				
	2020	2021	2022	2023	2024
Car	1038	908	795	695	608
Motorcycle	329	282	241	206	177

Source: Survey results, April 2020

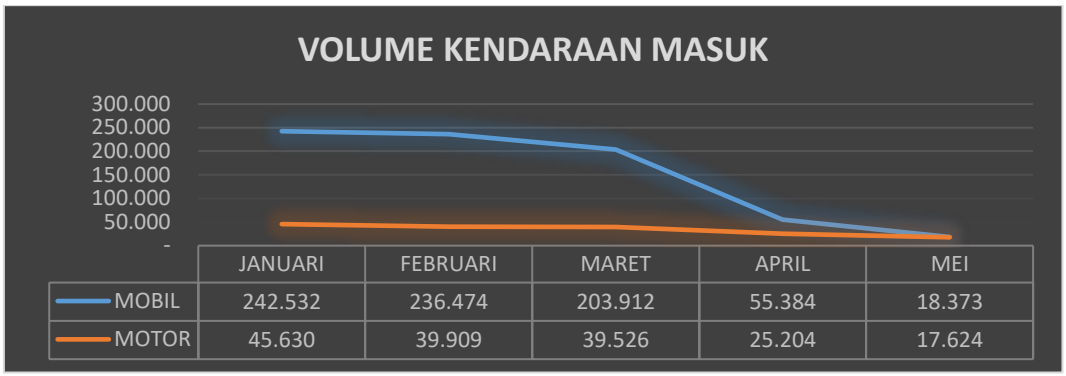
Table 5. Prediction of Need for Parking Plots in 2024

Transportation type	Accumulation of Vehicles	Parking Index (IP)	Number of Parking Plots (SRP)
Car	608	55%	334
Motorcycle	177	21%	37

Source: Researcher, April 2020

5.3 The Impact of the Covis-19 Pandemic on the Characteristics of Parking in Airport Areas

International Halim Perdanakusuma



	JANUARI	FEBRUARI	MARET	APRIL	MEI
MOBIL	242.532	236.474	203.912	55.384	18.373
MOTOR	45.630	39.909	39.526	25.204	17.624

Figure 7. Incoming Vehicle Volume Graph January 2020 - May 2020
Source: PT. Securindo Packatama Indonesia, April 2020

Based on the picture above, it can be seen that the volume of incoming vehicles decreased significantly starting in March 2020 with 203,912 car volumes and 39,529 motorbike volumes until May 2020 with 18,373 car volumes and 17,624 motor volumes. The decline that occurred in the volume of cars reached 91% and 55.4% for motorbikes.

5.4 Performance Analysis of Jalan Angkasa I Halim Perdanakusuma District

Makassar City, East Jakarta

5.4.1 Road Geometry

	Sisi A	Sisi B	Total	Rata-rata
Lebar Lalu Lintas Rata-rata (m)	3,5	3,5	7	3,5
Kereb (K) atau Bahu (B)	K	K		
Jarak Kereb - Penghalang (m)	Sisi A	Sisi B	Total	Rata-rata
Lebar Efektif Bahu (tidak ada, sedikit, banyak)	Sisi A	Sisi B	Total	Rata-rata

Figure 8. Geometry Conditions of the Road
Source: Survey results, April 2020

From the picture above, Jalan Angkasa I has an average width of 3.5 meters and has a sidewalk width of 3.2 meters towards Cawang and 1.95 towards the airport.

5.4.2 Traffic Volume

This volume can be expressed in terms of annual, daily, hourly or smaller terms. The rate of flow is defined as the hourly equivalent rate of vehicle traffic passing a point on a road in a time less than 1 hour, usually 15 minutes (Universitas Pembangunan Jaya, no date).

Table 6. Traffic Volume

No.	Road Width (m)	Roads	Time / Hour	Volume (pcu / hour) Weekday	Volume (pcu / hour) Weekend
1	7	Cawang direction	16.30 - 17.00	906	620
2	7		17.00 - 17.30	1238	958
3	7	Airport Directions	16.30 - 17.00	574	455
4	7		17.00 - 17.30	654	527

Source: Calculation Results

5.4.3 Capacity

The capacity of the Angkasa I Halim Perdanakusuma road section is calculated using the MKJI 1997 guidelines, the capacity is as follows:

Table 7. Capacity

Basic Capacity	Adjustment Factor for Capacity				Capacity
	Lane Width	Direction Separator	Side Barriers	City Size	
Co junior high school / hour	FCw	FCsp	FCsf	FCcs	C junior high school / hour (11) x (12) x (13) x (14) x (15)
(11)	(12)	(13)	(14)	(15)	(16)
2900	1	1	0.94	1	2726

Source: Calculation Results

5.4.4 Free Flow Speed

Jalan Angkasa I Halim Perdanakusuma is a 2-lane, undivided 2/2 UD road type with a traffic lane width of 7 meters.

Table 8. Free Flow Speed

Directions	Basic Free Flow Speed	Adjustment Factor For Path Width	FVo + FVw	Adjustment Factor		Free Flow Speed
				Side Barriers	City Size	
	FVo	FVw	(2) + (3)	FFVsf	FFVcs	FV (4) x (5) x (6)
	(km / h)	(km / h)	(km / h)			(km / h)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	44	0	44	1	1	44

Source: Calculation Results

5.4.5 Degrees of Saturation and Level of Service

The degree of saturation is the ratio between traffic volume and road capacity. The following is the calculation of the degree of saturation as follows:

Table 9. Degree of Saturation and Service Level

Day	Time	Degree of Saturation	Service Level
Weekday	16:30 - 17:30	0.479	A
Weekend	16:30 - 17:30	0.369	A

Source: Calculation Results

6. Conclussion

6.1 Conclusion

1. Parking characteristics for four-wheeled and two-wheeled vehicles have the highest parking accumulation of 1038 cars and 329 motorbikes. Parking vehicle duration ranges from 7 hours for motorbikes with 703 vehicles on 23 April 2020. The highest parking volume for four-wheeled vehicles is 3578 vehicles on 23 April 2020 and the highest for two-wheeled vehicles with 1180 vehicles on 01 April 2020, so also with the outbound parking volume also occurred on the same date for four-wheeled vehicles and two-wheeled vehicles.
2. From the results of the analysis of the vehicle parking characteristics at the airport for the mean car index of 82.9% and 33.1% for motorbikes in 4 hour intervals, this indicates that the parking index is less than 100% so it can be concluded that vehicle parking at Halim International Airport. Perdanakusuma still accommodates parking requests.
3. From the results of the analysis of the impact of the Covid-19 Pandemic, the volume of incoming vehicles decreased significantly, starting in March 2020 with 203,912 car volumes and 39,529 motorbikes until May 2020 with 18,373 car volumes and 17,624 motor volumes. The decline that occurred in the volume of cars reached 91% and 55.4% for motorbikes.
4. If the analysis is based on data carried out in April 2020, the results are that in 2024 the volume of parking entry vehicles for four-wheeled vehicles is 608 vehicles / 4 hours and for two-wheeled vehicles is 177 vehicles / 4 hours. If we look at the prediction of the need for parking lots in 2024 for four-wheeled vehicles of 334 SRP and 37 SRP for two-wheeled vehicles, it means that the parking lot is still able to accommodate the number of vehicles entering the parking lot.
5. Based on the results of the performance analysis of Jalan Angkasa I Halim Perdanakusuma, it is 1305 pcu / hour on weekdays and 1007 sm / hour on holidays. The free flow speed of the vehicle is 44 km / h. At the weekend the degree of saturation is 0.026 with a service level of free flow, low volume and high speed.

6.2 Suggestions

1. Further research is needed to see the characteristics of vehicle parking at Halim Perdanakusuma International Airport after the new normal conditions take effect so that accurate data can be obtained for analyzing parking characteristics for the next 5 years.
2. It is better if field service staff are provided / placed in each parking area to help tidy up parked vehicles so that the provision of parking spaces becomes more effective.

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Analysis of the behavior and performance of the short link eccentric brace frame type multistory x-brace with variable link length and L / H ratio

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Abstract

In the process of planning earthquake-resistant building structures, steel structures are still an option. This is because steel material has relatively high load resistance and elastic properties of steel which contribute to better ductility and energy dissipation than concrete. Eccentric Brace Frame System (SRBE) is a lateral load bearing system that has good strength, stiffness and ductility. In this study, the SRBE Short Link Multistory X-bracing type structure with variable link length and L / H ratio was evaluated using pushover analysis to determine the structure's behavior and performance in terms of stiffness, strength and ductility of the structure. The analysis was conducted on 9 10-story building models with different link lengths and L / H ratio. From the results of the comparative analysis of each structural model, it is found that the C2 model with a link length of 900 mm and an L / H ratio of 1.5 has a stiffer structure. Model C3 with a link length of 900 mm and a ratio of L / H = 1.75 has a greater strength to withstand earthquake loads. The use of a link length of 300 mm and an L / H ratio = 1.5 results in an increasingly ductile structure. The results of the structural performance are at the Immidiate Occupancy level, but there are several models with one of the X or Y load directions that have a Life Safety structural performance level. The use of a link length of 300 mm and an L / H ratio = 1.5 results in an increasingly ductile structure. The results of the structural performance are at the Immidiate Occupancy level, but there are several models with one of the X or Y load directions that have a Life Safety structural performance level. The use of a link length of 300 mm and an L / H ratio = 1.5 results in an increasingly ductile structure. The results of the structural performance are at the Immidiate Occupancy level, but there are several models with one of the X or Y load directions that have a Life Safety structural performance level.

Keywords
Eccentric Brace Frame System, Link, Pushover Analysis, Structural Performance

1. Introduction

The existence Indonesia is a country that has many areas with a high level of seismic vulnerability. For this reason, the structural plan must be designed to withstand the lateral forces generated by the earthquake. In the process of planning earthquake-resistant building structures, steel structures are still the favorite choice of civil engineering practitioners as an earthquake-resistant building structure material. This happens because the steel material has relatively high strength to withstand loads and the elastic properties of steel which contribute to better ductility and energy dissipation than concrete materials (Dewobroto, 2015).

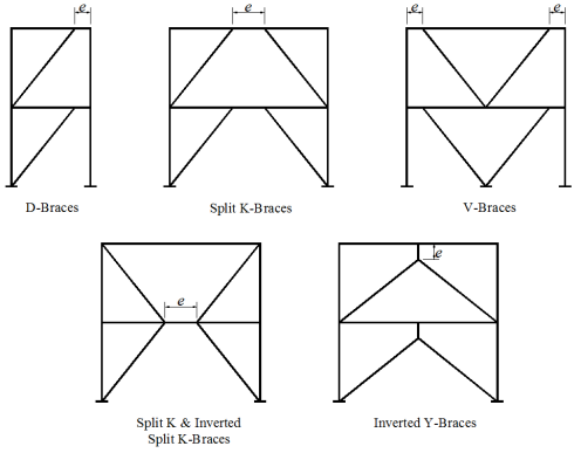

Figure 1. Some possible placement of bracing for an EBF structural system.

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The Eccentric Brace Frame System (SRBE) is a special lateral load bearing system, because the SRBE is a combined combination of the highly ductile Moment Bearer Frame System (SRPM) and the Concentric Brace Frame System (SRBK) which has fairly good rigidity and strength (Daneshmand, Ardeshir and Hashem, 2011).

The split-type K-Braces EBF portal model that uses short links (e = 100 cm) is better and is recommended for its use in structures compared to medium links (e = 200 cm) and long links (e = 300 cm). This is indicated by the failure mechanism on the link is achieved earlier in the short link than the other models (Rafael and Suswanto, 2017). Meanwhile, another study on SRBE reported that links greater than 20% of beam span length resulted in a more ductile structure (Niknam and Sharfaei, 2011).

From some of these studies it becomes clear that the link length on the SRBE plays an important role, but there are still doubts whether the shorter or longer links are in the Short Link category with different length and height ratio (L / H) which results in a more effective and efficient structure. . In this study, the SRBE Short Link Multistory X-bracing type structure with variable link length and L / H ratio was evaluated using pushover analysis to determine the structure's behavior and performance in terms of stiffness, strength and ductility of the structure. The analysis was carried out on 9 10-story building models with different link lengths and L / H ratio.

2. Methods

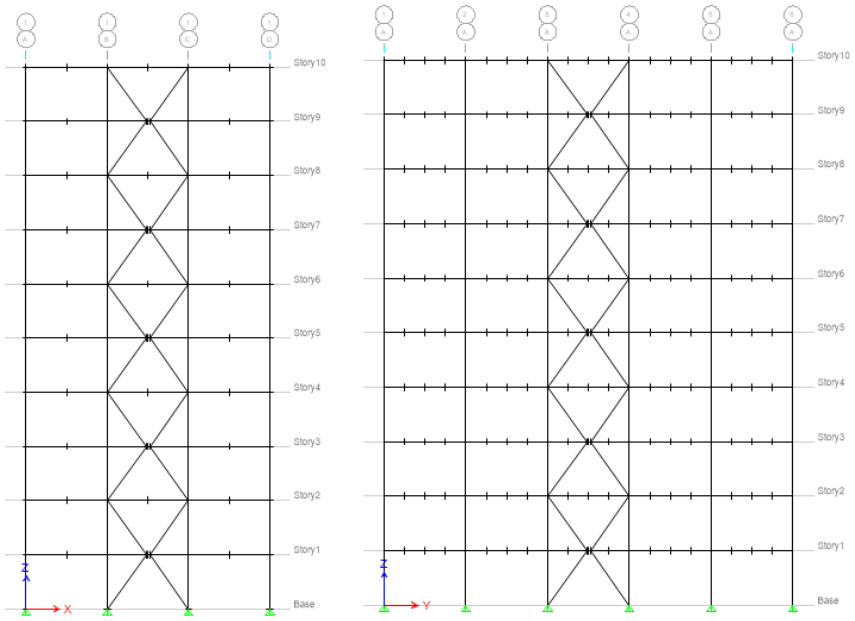
2.1. Planning for the EBF Structure

In the Eccentric Brace System there is a part of the beam called a link and is specially planned. SRBE is expected to experience considerable inelastic deformation at the link when carrying forces due to the design earthquake load because the link element functions as energy anticipation when the structure receives earthquake loads. This energy dissipation is manifested in the form of plasticification in the link elements.

The analysis was carried out on 9 10-story building models with different link lengths and L / H ratio. The structural analysis process is generally carried out with the help of commercial structural analysis software.

Table 1. Description of Structural Modeling

Model	A			B			C		
	1	2	3	1	2	3	1	2	3
Beam Length (m), (L)	5	6	7	5	6	7	5	6	7
L / H ratio	1.25	1.5	1.75	1.25	1.5	1.75	1.25	1.5	1.75
Link Distance (mm)		300			600			900	



(a) (b)

Figure 2. The x (a) direction portal model, the y (b) direction portal model.

2.2. Pushover Analysis

The net result is the base shear and displacement of the structure. These values are depicted in the capacity curve which illustrates the behavior of the structure. Pushover curve is influenced by the distribution pattern of the lateral force which is used as a thrust load.

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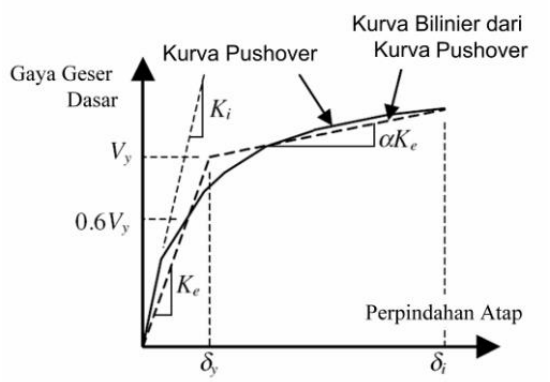

Figure 3. Pushover Curve (FEMA 356)

The force and deformation of each component / element are calculated against the "specified displacement" at the control point which is referred to as "displacement target" with the notation δt and is considered as the maximum displacement that occurs when the building experiences a planned earthquake. The method used to determine the displacement target is the FEMA 356 (American Society Of Civil Engineers, 2000). Displacement Target Method. The displacement target is carried out by modifying the linear elastic response with the coefficient factors C0, C1, C2, and C3 in order to obtain the maximum global displacement (elastic and inelastic).

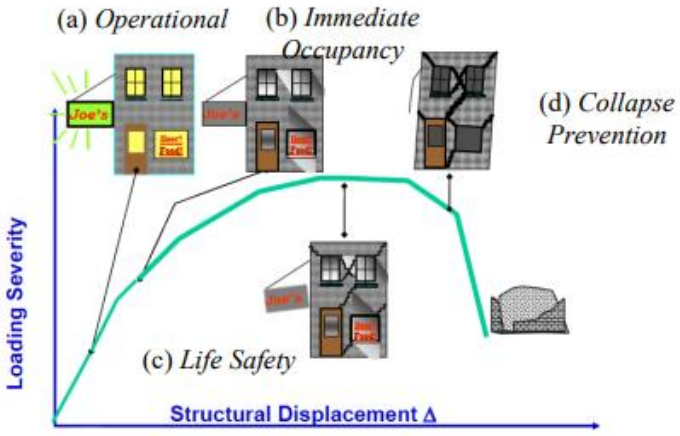

Figure 4. Performance Level

3. Results And Discussion

To determine the behavior and performance of the model model of the eccentric brace system type multistory x-brace, it will be reviewed from the stiffness, strength and ductility of the structure due to the applied pushover analysis.

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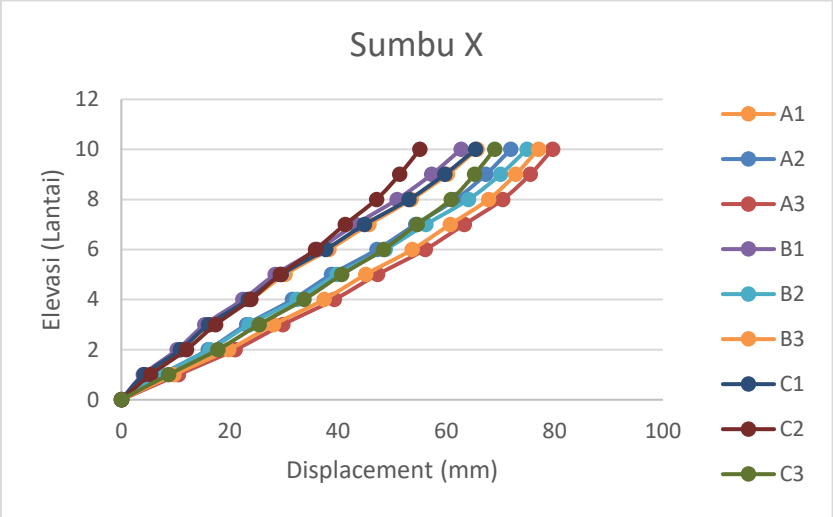

Figure 5. Deviation of the building in the direction of the X axis

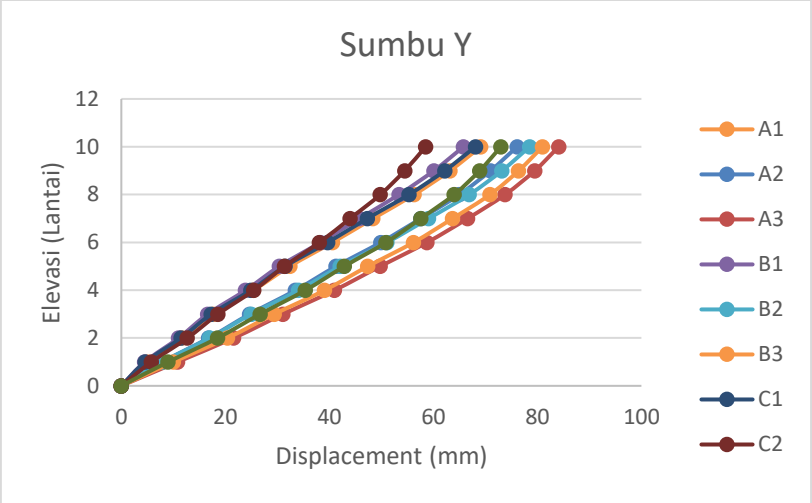

Figure 6. Deviation of the building in the direction of the Y axis

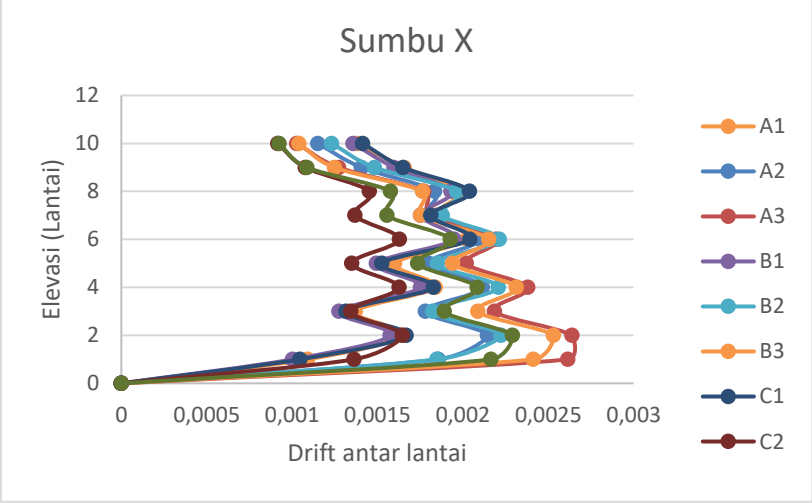

Figure 7. Drift between floors in the direction of the X axis

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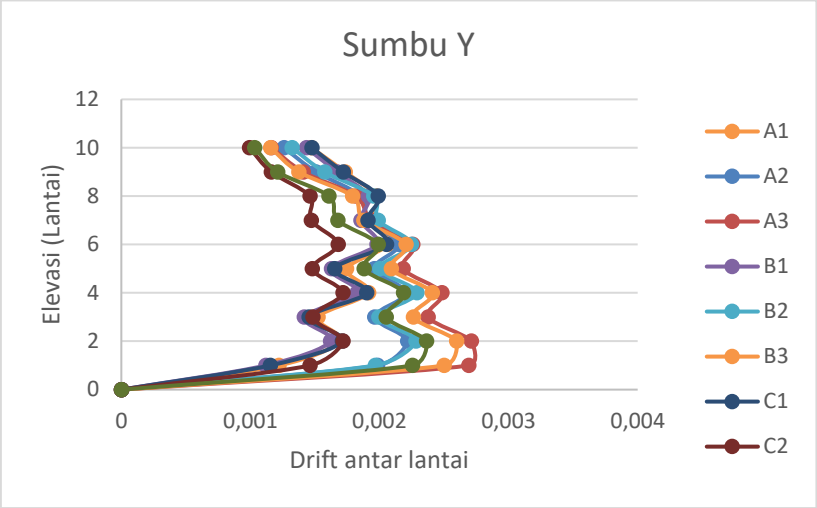

Figure 8. Drift between floors in the direction of the Y axis

From the image of the lateral deviation and drift between floors in the direction of the X axis and the direction of the Y axis above, it is found that the C2 model has smaller lateral deviations and the drift between floors is in the X direction or Y axis direction compared to other structural modeling. This shows that a structure with a link length of 900 mm and an L / H ratio of 1.5 has a stiffer structure compared to other structural models.

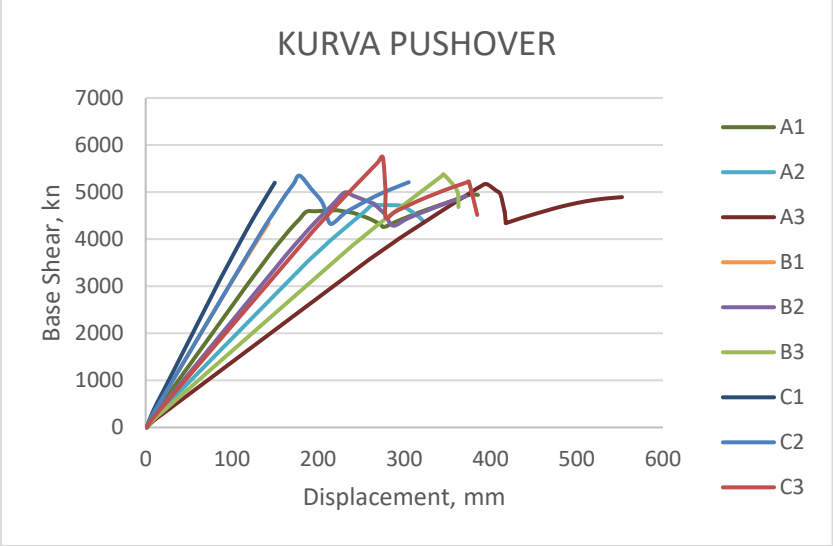

Figure 9. Comparison of the X-axis directional pushover curve

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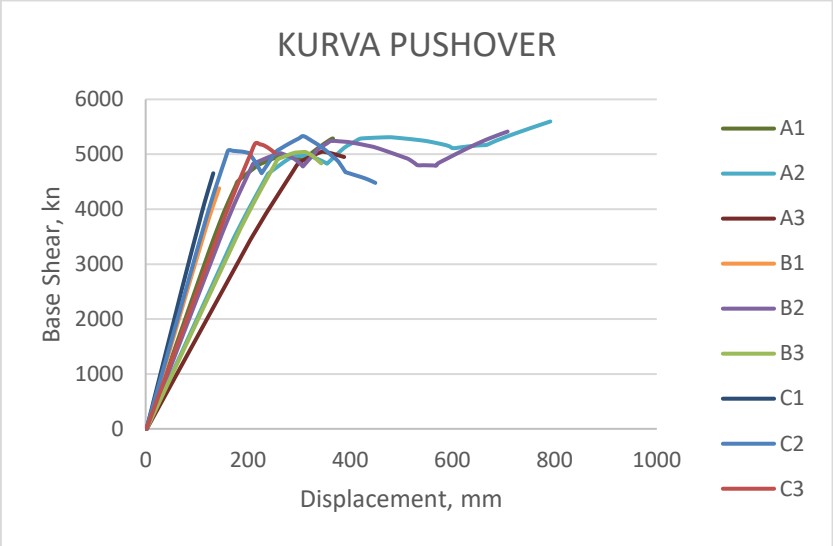

Figure 10. Figure 4.6 Comparison of the Y axis pushover curve

Based on the picture above, it can be seen that the C3 model with a link length of 900 mm and a ratio of L / H = 1.75 has a greater strength to withstand earthquake loads compared to other structural modeling. This is because the ultimate bottom shear force that occurs (namely the maximum base shear force that can be held by the structure before a decrease in strength occurs) in C3 modeling is greater than that of other structural models. From the comparison of the pushover curve for the X and Y axis directions, in B1 and C1 modeling, the structure experiences a failure before a decrease in strength occurs. This can occur due to the structural geometry or the use of inappropriate link lengths so that the structure is vibrating or brittle.

Table 2. Results of the analysis of the performance level of the structure

Model	Arah Beban	H total (m)	Dt (m)	Drift (%)	Level Kinerja Struktur
A1	X	40	0,386	0,96	Immidiate Occupancy
	Y	40	0,367	0,92	Immidiate Occupancy
A2	X	40	0,323	0,81	Immidiate Occupancy
	Y	40	0,792	1,98	Life Safety
A3	X	40	0,553	1,38	Life Safety
	Y	40	0,388	0,97	Immidiate Occupancy
B1	X	40	0,143	0,36	Immidiate Occupancy
	Y	40	0,144	0,36	Immidiate Occupancy
B2	X	40	0,372	0,93	Immidiate Occupancy
	Y	40	0,708	1,77	Life Safety
B3	X	40	0,363	0,91	Immidiate Occupancy
	Y	40	0,344	0,86	Immidiate Occupancy
C1	X	40	0,150	0,37	Immidiate Occupancy
	Y	40	0,132	0,33	Immidiate Occupancy
C2	X	40	0,305	0,76	Immidiate Occupancy
	Y	40	0,449	1,12	Life Safety
C3	X	40	0,385	0,96	Immidiate Occupancy
	Y	40	0,25	0,63	Immidiate Occupancy

The results of the model structure performance of the eccentric bracing system (SRBE) type multystory x-brace are at the IO (Immidiate Occupancy) level, but there are several models with one of the X or Y load

directions which have a performance level of the LS (Life Safety) structure referring to the drift provisions. FEMA 356 (American Society Of Civil Engineers, 2000).

Table 3. Number of plastic hinges that occur at the final step of each structural modeling

Model	Arah	Displacement (m)	Base Shear (Kn)	A-B	B-IO	IO-LS	LS-CP	CP-C	C-D	D-E	Beyond E	Total
A1	X	0,385	4927,06	1289	5	19	1	0	4	0	2	1320
	Y	0,367	5286,42	1276	8	30	0	0	4	0	2	1320
A2	X	0,323	4360,03	1297	7	12	0	0	2	0	2	1320
	Y	0,792	5597,12	1242	8	20	4	12	28	0	6	1320
A3	X	0,553	4893,20	1276	15	20	3	2	2	0	2	1320
	Y	0,388	4950,50	1280	10	24	0	1	4	1	0	1320
B1	X	0,143	4341,54	1313	5	0	0	0	2	0	0	1320
	Y	0,144	4377,95	1314	0	2	0	0	4	0	0	1320
B2	X	0,372	4913,42	1291	5	18	0	0	4	0	2	1320
	Y	0,708	5413,44	1251	7	16	10	8	22	0	6	1320
B3	X	0,363	4681,90	1297	6	15	0	0	2	0	0	1320
	Y	0,344	4834,54	1293	5	16	1	0	3	0	2	1320
C1	X	0,150	5199,24	1312	0	2	0	0	6	0	0	1320
	Y	0,132	4654,22	1314	0	0	0	0	6	0	0	1320
C2	X	0,305	5210,15	1288	6	20	0	0	4	0	2	1320
	Y	0,449	4478,76	1254	2	38	17	1	2	0	6	1320
C3	X	0,385	4515,17	1284	9	21	2	0	2	0	2	1320
	Y	0,253	5023,36	1316	4	0	0	0	0	0	0	1320

Based on the table above, for the direction of the Y-axis loading, the most plastic hinges occur in A2 modeling with a link length of 300 mm and a ratio of L / H = 1.5. In addition to A2 modeling, plastic hinges for the Y-axis loading direction also occur frequently in B2 and C2 modeling. Whereas for the X-axis loading direction, the most plastic hinges occurred in A3 modeling with a link length of 300 mm and the ratio L / H = 1.75. In addition to A3 modeling, plastic hinges for the X-axis loading direction also occur in C3 modeling. This shows that the structure is more ductile with the use of a link length of 300 mm compared to the use of link lengths of 600 mm and 900 mm, besides that the structure is also more ductile with the use of the ratio L / H = 1.5 for the eccentric bracing frame type multystory x-brace. In A3 modeling with the ratio L / H = 1.

4. Conclusions

From the results of the analysis of the behavior and performance of the short link eccentric bracing frame type multystory x-brace as many as 9 models with varying link lengths and L / H ratios using the pushover analysis method, the following conclusions can be drawn:

1. C2 modeling has greater stiffness in withstanding earthquake loads compared to other structural modeling. This is because C2 modeling with a link length of 900 mm and an L / H ratio of 1.5 has the smallest building deviation and drift between floors in the X and Y axis directions.
2. Model C3 with a link length of 900 mm and a ratio of L / H = 1.75 in the direction of the X axis and the Y axis has a greater strength (strength) to withstand earthquake loads compared to other structural modeling.This is due to the ultimate shear force that occurs (that is, the maximum basic shear force that can be held by the structure before a decrease in strength occurs) in C3 modeling is greater than that of other structural models. So that in the eccentric brace type multystory x-brace frame structure, the strength of the structure increases with the increase in link length and the L / H ratio used.
3. A2 modeling with a link length of 300 mm and an L / H ratio of 1.5 has greater ductility in withstanding earthquake loads compared to other structural models. This is due to the large number of plastic joints that occur as a result of the pushover analysis in A2 modeling.
4. The results of the model structure performance of the eccentric bracing system (SRBE) type multystory x-brace are at the IO (Immidiate Occupancy) level, but there are several models with one of the X or Y load directions which have a performance level of the LS (Life Safety) structure referring to the drift provisions. FEMA 356 (2000).

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Analysis of Traffic Accidents and Handling with Aek and Bka Methods to Determine Accident-Prone Areas (A Case Study of The Bogor District Government Road Area)

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Abstract

Bogor Regency with the largest population in Indonesia, namely as many as 5.9 million people. With the population in the area classified as very large, the number of traffic accidents in Bogor Regency is high, namely 357 accidents in 2018. It affects the level of traffic density, but this condition is not balanced with adequate road facilities and infrastructure and public transportation. Of course this causes an increase in the volume of traffic in the Bogor Regency Regional Government Road Area and also increases the potential for accidents. The research objectives were to determine the performance of roads, accident-prone roads, dominant causes of accidents, and to know the prevention of accidents in the Bogor District Government Road Area using the Accident Equivalent Rate (AEK), Upper Control Limit (BKA) method. Based on the analysis, it is concluded that Jalan Raya Bogor, Jalan Raya Sukahati - Karadenan, and Jalan Tegar Beriman are included in the category of roads prone to traffic accidents, because they have AEK values that exceed or are greater than the BKA and UCL values. The most common type of accident was Front-Forward crash, which accounted for 39.51% of the total number of accidents. The time of accidents that most often occur in the area of Bogor Regency Regional Government Road is in the morning at 00.00 WIB - 06.00 WIB with a percentage of 28.53% of the number of accidents.

Keywords
Accident Equivalent Rate, Accident-Prone Areas, Roads, Traffic Accidents,

1. Introduction

1.1 Background

In Indonesia, the number of accidents that occurred during 2013 to 2018 is quite high. The highest number of accidents occurred in 2016, where there were accidents as many as 106,644 cases. West Java Province is one of the provinces with the largest population in Indonesia with a population of 49.02 million. One of the several districts in West Java is Bogor Regency with the largest population in Indonesia, namely as many as 5.9 million people. With the population in the area classified as very large, the number of traffic accidents in Bogor Regency is high, namely 357 accidents in 2018. This condition is not matched by adequate road facilities and infrastructure and public transportation.

Based on the above background, in this case it is necessary to carry out a traffic accident analysis which includes identification of accident-prone locations, identification of accident characteristics, and proposed handling of accident-prone areas. So in an effort to add to the scientific repertoire to help reduce accidents in the Bogor Regency Regional Government Road Area, it is necessary to conduct a study with the title "Traffic Accident Analysis and Handling with AEK and BKA Methods to Determine Accident-Prone Areas." (A Case Study of Bogor District Government Road Area).

2. Literature Review

2.1 Road Section Performance

Road performance is the ability of a road to serve the needs of traffic flow according to its function which can be measured and compared with road service level standards. The value of road service level is used as a parameter of road performance (Valent et al., 2002).

Meanwhile, according to MKJI (1997), road performance can be measured based on several parameters, including:

Degree of saturation (DS), namely the ratio of traffic flow (pcu / hour) to capacity (pcu / hour) on a certain road section.

2.2 Roads and Traffic Accidents

Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are on the ground surface, above the ground surface, below the ground and / or water, and above the water surface, except for railways, roads. lorries, and cable roads (Nugroho, Sutarto, Endradewi, & Alisa, 2017) .

A traffic accident is an incident on the road which is unexpected and unintentionally involving a vehicle with or without other road users resulting in human casualties and / or property loss (WHO, 2018).

2.3 Identification of Accident Prone Locations

There is a method that can be used to identify accident-prone locations, namely the Accident Equivalent Rate (AEK) method. According to guideline Halim, Sultan, & Saing, (2018) regarding Handling of Traffic Accident-Prone Locations, AEK is the number used to weight the class of accidents, this figure is based on the value of accidents with material damage or loss.

To weight the rates of accidents that occur on roads, it is done by using a comparison of the monetary value of the cost of accidents, with a comparison:

M: B: R: K = M / K: B / K: R / K: 1……. (2.4)

with:

M = Passed Away
B = Serious Injury
R = Minor Injuries
K = Accidents with Material / Object Loss

3. Research Methodology

3.1 Research Location and Time

Analysis The research was conducted in the area of Jalan Pemda Bogor Regency. The time of writing of this research was carried out in February 2020 - July 2020 using data on traffic accidents in 2016 - March 2020. The road segment performance survey was conducted on Friday and Saturday at 06.30-07.30 WIB and 17.00-18.00 WIB.

3.2. Method of Analysis of Accident Handling Efforts

The purpose of this analysis is to provide an effort to deal with accidents at the accident location in the Bogor Regency Regional Government Road Area based on the accident situation at that location. This analysis can be done after looking at the types of accidents that are considered dominant in accident-prone locations. After obtaining the dominant type of accident at the accident location, a survey of road conditions and / or road safety facilities at the accident-prone location is carried out to obtain a recommendation for appropriate treatment.

4. Analysis and Discussion

4.1 Overview

The road sections around the Bogor Regency Regional Government sector consist of several roads, and in this research the road sections to be analyzed are 8 roads consisting of 1 national road section (Jl. Raya Bogor) and 7 regency roads (Jl. Raya Sukahati, Karadenan, Jl. Tegar Beriman, Jl. Sukahati-Bojong Gede, Jl. Cilebut-Citayam, Jl. Kemang-Kedungwaringin, Jl. Sentul-Kandang Roda, and Jl. Pomad Karadenan). The following is a map of the location of 8 roads (national road red color, district road blue color) which will be analyzed can be seen in Figure 1.

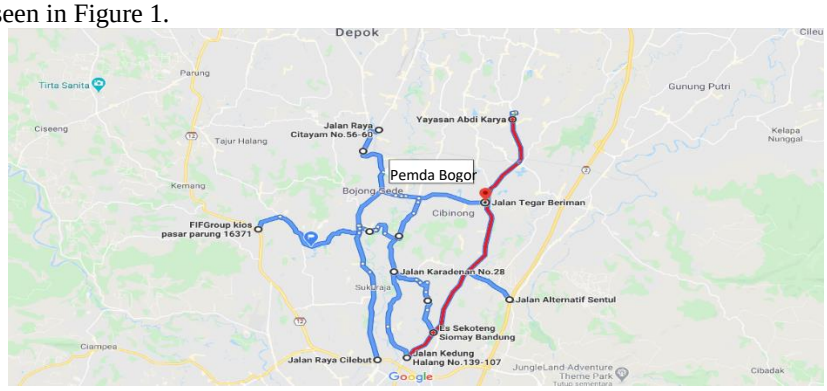

Figure 1. Location Map
Source: www.google.co.id/maps

4.2 Data Recapitulation

This data is obtained from POLRES DISTRICT BOGOR which is used to answer problems regarding the location of accident-prone points. The data obtained were in the form of data recapitulation of victim fatality, data on factors causing traffic accidents, and data on accident events. The recapitulation table of victim fatality data in the Bogor Regency Regional Government sector in 2016 to March 2020 each year can be seen in Table 1.

Table 1. Recapitulation of Total Victim Fatality Data

NO	Roads	Number Of Events	Victim			Number Of Victims	Material Losses	
			MD	LB	LR		THING	Rp
1	Jl. Raya Jakarta-Bogor	80	29	15	50	94	107	25,500,000
2	Jl. Raya Sukahati Karadenan	76	20	7	62	89	87	8,000,000
3	Jl. False	40	7	14	26	47	46	7,200,000
4	Jl. Sukahati-Bojong Gede	15	2	4	12	18	26	2,500,000
5	Jl. Cilebut-Citayam	4	0	0	5	5	11	800,000
6	Jl. Kemang-Kedungwaringin	18	7	4	10	21	29	2,200,000
7	Jl. Wheel Houses	9	0	3	8	11	17	2,050,000
8	Jl. Pomad Karadenan	0	0	0	0	0	0	-

Source: Bogor District Police

From the accident data on the road, the most frequent accidents are Jalan Raya Bogor with 80 incidents, followed by Jalan Raya Sukahati Karadenan with 76.

4.3 Road Section Performance Analysis

Based on the Recapitulation of Victim Fatality Data (Table 1.) the road with frequent accidents is Jalan Raya Bogor with a total of 80 incidents, therefore, first of all it is necessary to review how the performance on these roads is, the first step is to carry out a survey by counting the vehicles for 1 hour. at every busy hour, where the observation time taken is at 06.30 - 07.30 WIB, and 17.00 - 18.00 WIB, Based on the data obtained, the calculation of traffic volume, capacity, free flow speed, degree of saturation, travel time and analysis is carried out. service level based on the Indonesian Road Capacity Manual (MKJI),

4.3.1 Traffic Volume

Traffic volume is the number of vehicles passing on a certain road in hours.

Table 2. Traffic Volume During the Covid-19 Pandemic

No.	Road Width (m)	Roads	Time / Hour	Volume (pcu / hour) Weekdays	Volume (pcu / hour) of holidays
1	7	Bogor Direction	06.30 - 07.30	1409	1658
2	7		17.00 - 18.00	2035	2443
3	7	Direction of Jakarta	06.30 - 07.30	1514	1316
4	7		17.00 - 18.00	1781	1958

Source: Calculation Results

4.3.2 Free Flow Speed

Jalan Raya Bogor is a 4-lane - 2-way divided (4/2) road type, with a traffic lane width of 7 meters. The calculation of free flow speed is based on the Indonesian Road Capacity Manual (MKJI, 1997) for urban routes. The following is the calculation of the speed of the free flow of vehicles based on the MKJI 1997.

Table 3 Free Flow Speed During the Covid-19 Pandemic

Directions	Basic Free Flow Speed	Adjustment Factor For Path Width	FVo + FVw	Adjustment Factor		Free Flow Speed
				Side Barriers	City Size	
	FVo	FVw		FFVsf	FFVcs	FV
	(km / hour)	(km / hour)	(2) + (3) (km / hour)			(4) x (5) x (6) (km / hour)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	57	0	57	1	1.03	58.71

Source: Calculation Results

4.3.3 Capacity

The capacity of Jalan Raya Bogor is calculated using the MKJI 1997 guidelines, the capacity is as follows:

Table 4. Capacity During the Covid-19 Pandemic

Directions	Basic Capacity	Adjustment Factor for Capacity				Capacity
		Lane Width	Direction Separator	Side Barriers	City Size	
	Co junior high school / hour	FCw	FCsp	FCsf	FCcs	C junior high school / hour (12) x (13) x (14) x (15) x (16)
(11)	(12)	(13)	(14)	(15)	(16)	(17)
1 (direction Bogor)	3300	1	1	0.96	1.04	3295
2 (direction to Jakarta)	3300	1	1	0.96	1.04	3295

Source: Calculation Results

4.3.4 Degree of Saturation and Service Level

The degree of saturation is the ratio between traffic volume and road capacity. The level of service is done by comparing the volume of vehicles in units of pcu / hour with the capacity of the roads. The following are the results of Degree of Saturation and Service Level for two directions:

Table 5. Degree of Saturation and Service Level During the Covid-19 Pandemic

Day	Time	Directions	Degree of Saturation	Service Level
Weekdays	Morning	Bogor	0.428	B
		Jakarta	0.459	B
	Afternoon	Bogor	0.618	C
		Jakarta	0.541	C
Weekend	Morning	Bogor	0.503	B
		Jakarta	0.399	B
	Afternoon	Bogor	0.741	C
		Jakarta	0.594	C

Source: Calculation Results

4.3.5 Comparison of The Degree of Saturation Before and During the Covid-19 Pandemic

Comparative data for the performance of Jalan Raya Bogor before Covid-19 used here is the journal by Rulhendri Agus Hasan from the University of Ibn Khaldun Bogor with the title 'Performance Evaluation of Jalan Raya Bogor (Case Study: Jalan Raya Bogor) ”in 2018.

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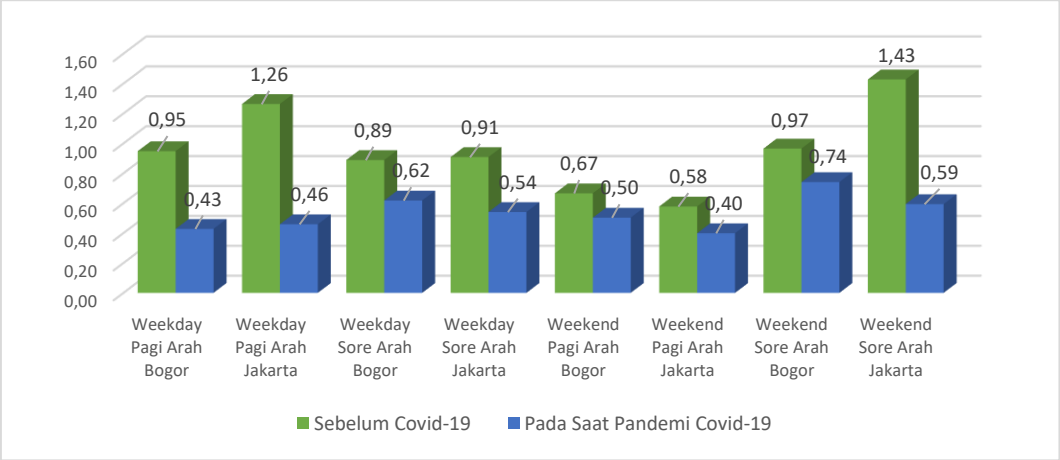

Figure 2. Comparison of the Degree of Saturation Before and During the Covid-19 Pandemic
Source: Calculation Results

4.4 Analysis of Accident Prone Areas

The analysis of accident-prone areas in this study uses the Accident Equivalent Rate (AEK) method. This method is used to determine accident-prone areas by ranking the AEK value with the Upper Control Limit (BKA) and Upper Control Limit (UCL) values based on the number and fatality rate of accident victims that occurred in the Bogor Regency Regional Government Road Area.

AEK formula:

AEK = 12MD + 3LB + 3LR + 1K (4.1)

The calculation of AEK that is reviewed is in the Bogor Regency Regional Government Road Area which is divided into 8 roads. The BKA calculation can be calculated using the average AEK value on the road sections under review.

BKA formula

BKA = C + 3√C (4.2)

Where the value of C is the average of the equivalent accident rate (AEK).

UCL calculations can be calculated using the average AEK value on the road sections under review.

UCL formula

$$UCL = \lambda + \Psi \times \sqrt{\left(\frac{\lambda}{m} + \frac{0{,}829}{m} + \left(\frac{1}{2}xm\right)\right)} \quad (4.3)$$

The results of the calculation of the identification of accident-prone locations using the AEK method can be seen in Table 6.

Table 6. Calculation of Accident-Prone Location Identification

NO	Roads	Score					
		AEK	C	BKA	λ	ψ	UCL
1	Jl. Raya Jakarta-Bogor	650	220,375	264,9101	220,375	2,576	266,839
2	Jl. Raya Sukahati Karadenan	534					262,500
3	Jl. False	250					249,277
4	Jl. Sukahati-Bojong Gede	98					238,818
5	Jl. Cilebut-Citayam	26					232,322
6	Jl. Kemang-Kedungwaringin	155					243,260
7	Jl. Wheel Houses	50					234,348
8	Jl. Pomad Karadenan	0					0,000

Source: Calculation Results

4.5 Analysis of Data Analysis Approaches

4.5.1 Causes of Accidents

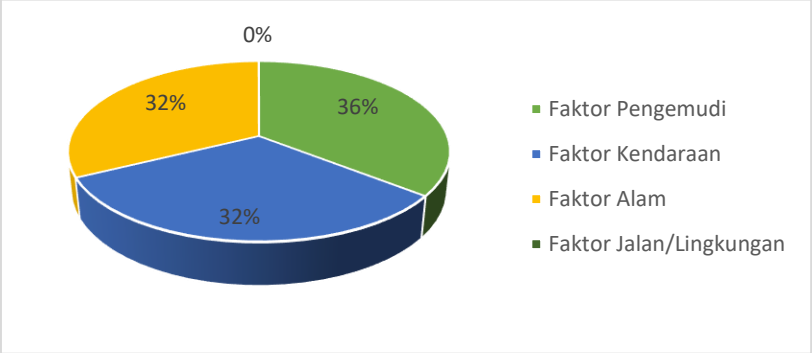

Figure 3. Pie Chart of Accident Causes
Source: Calculation Results

Based on the diagram in Figure 4, it can be seen that the largest percentage of the factors causing the accident is the driver factor.

4.5.2 Accident Type

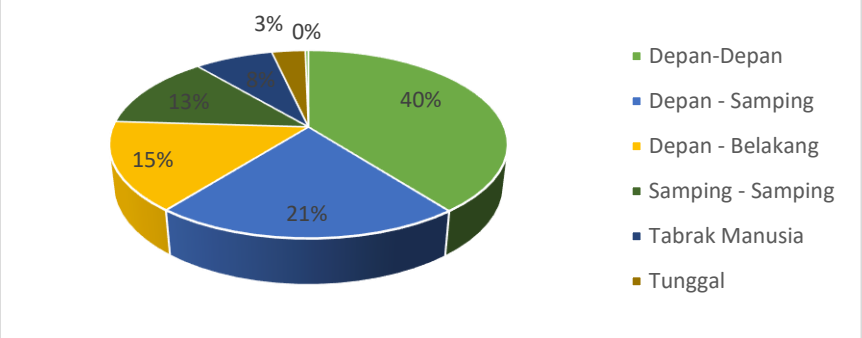

Figure 4. Pie Chart of Accident Types
Source: Calculation Results

Based on the percentage results in Figure 5, it can be seen that the largest percentage of accident types is front-to-front.

4.5.3 Time of The Crash

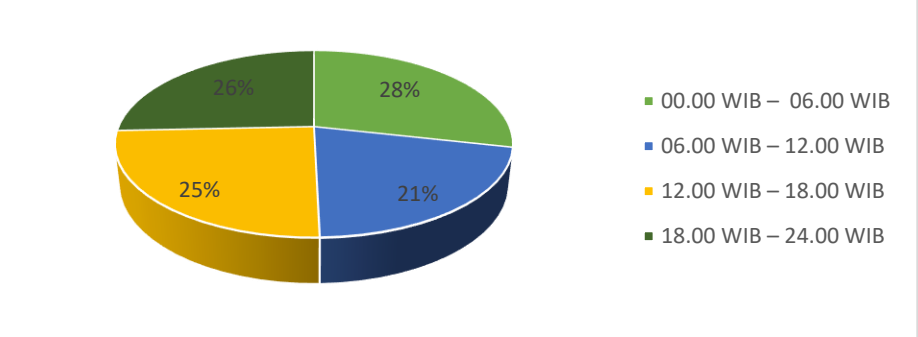

Figure 5. Time Accident Pie Chart
Source: Calculation Results

Based on the percentage results in Figure 5, it can be seen that the time of the biggest accident is 00.00 WIB - 06.00 WIB.

5. Conclusion

5.1 Conclusion

1. Based on the results of the analysis of the performance of Jalan Raya Bogor during the Covid-19 outbreak, the traffic volume on Jalan Raya Bogor is 1409 pcu / hour on Morning Workdays towards Bogor; 1514 pcu / hour on Morning Workdays towards Jakarta; 2035 pcu / hour on Afternoon Workdays towards Bogor; 1781 pcu / hour on Afternoon Work days towards Jakarta; 1658 junior high school / hour on Morning Holidays towards Bogor; 1316 pcu / hour on Morning Holidays towards Jakarta; 2443 pcu / hour on Afternoon Holidays towards Bogor; 1958 junior high school / hour on Afternoon Holidays towards Jakarta; while the capacity is 3300 pcu / hour. The free flow speed of the vehicle is 58.71 km / hour. The degree of saturation on Jalan Raya Bogor is 0.43 on a Morning Workday towards Bogor; 0.46 on a morning working day towards Jakarta; 0.62 on an Afternoon Weekday towards Bogor; 0.54 on Afternoon Workdays towards Jakarta; 0.50 on a morning holiday towards Bogor; 0, 40 on a morning holiday towards Jakarta; 0.74 on an Afternoon Holiday towards Bogor; 0.59 on Afternoon Holidays towards Jakarta. The results of comparisons before and during the Covid-19 pandemic show that there has been a decrease in the degree of saturation caused by the reduced volume of traffic flow during the Covid-19 pandemic.
2. Based on the results of the analysis of accident-prone locations in the Bogor Regency Regional Government Road Area in 2016 - March 2020 using the Accident Equivalent Rate (AEK), Upper Control Limit (BKA), and Upper Limit Control (UCL) method, it is concluded that Jalan Raya Bogor with an AEK value of 650 , Jalan Raya Sukahati Karadenan with an AEK value of 534, and Jalan Tegar Beriman with an AEK value of 250 where the BKA value is only 264,910 and the UCL value is 266,839 on Jalan Tegar Beriman, 266.5 on Jalan Raya Sukahati Karadenan, and 249,277 on Jalan Tegar Have faith. These roads are categorized as roads prone to traffic accidents, because they have an AEK score that exceeds or is greater than the BKA and UCL scores.
3. The factors causing traffic accidents in the Bogor Regency Regional Government Road Area in 2016 - March 2020 include:
   a. The driver's factor is the most dominant cause of accidents with a percentage of 35.52% with the majority of motorists who do not have orderly traffic.
   b. Lack of facilities for pedestrians such as zebra crossings to cross the road, the color of road markings and sidewalks is faded, the road surface has lots of holes or puddles and patches of holes that arise, and there are several road points that are not exposed to lighting are additional factors that can trigger an accident.
4. Solutions and handling of traffic accidents in the future area of the Bogor Regency Regional Government, namely:
   a. Installing and repainting road markings, zebra crossings, sidewalks or curbs according to the function and placement as needed on Jalan Raya Bogor
   b. Perform periodic surveillance work on Jalan Raya Bogor to prevent road damage that may result in traffic accidents.

5.2 Suggestions

1. There are improvements to Jalan Raya Bogor and Jalan Tegar Beriman including: Making zebra crossings for pedestrians, repainting road and sidewalk markings, repairing potholes, adding supporting signs, cutting trees that block street lighting, and checking periodically the street lights that are already dim or dead / not working.
2. Additional analysis needs to be done to complement secondary data such as the coordinates of each accident, the number of vehicles involved, weather, gender and age of the victim. And other methods can also be used in determining accident-prone points in the Bogor Regency Regional Government Road Area to get more accurate results.

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Biography

Dr. Andri Irfan Rifai ST., MT. is a lecturer at Mercu Buana University and chair of the undergraduate civil engineering program at Batam International University. Obtained a Bachelor's degree in Civil Engineering from Sebelas Maret University, a Masters in Civil Engineering from the University of Indonesia and a PhD in Transportation Engineering from the University of Indonesia - Universidade do Minho, Portugal. Dr. Andri Irfan Rifai ST., MT. also worked at the Indonesian Ministry of Public Works and Housing as a Project Manager for the Rehabilitation and Reconstruction project in the Palu Disaster Area.

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Study of Bridge Upper Structure Design with Composite Box Girder for Coal Mining Trailer Loads (Case Study: Belayan River - Kutai Kartanegara)

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Abstract

In the process of mobilizing coal on mine hauling road, which have to cross rivers, a bridge that is capable of carrying the traffic load from the mining truck is required. This study aims to plan a bridge structure with a composite box girder for coal mine trailer loads. In this study, the authors conducted a loading analysis based on SNI 1725 (2016) and planning the cross-sectional proportions based on the applicable provisions in (AASHTO, 2017). This research was carried out in several stages, starting from design of section proportions, flexure design, shear design, stiffener and shear connector. The results of this study show that the composite box girder can be applied at the research location and also the proportion of the cross-section that is able to withstand traffic loads working on the bridge structure with a nominal moment resistance value of 78856.13 kN.m which is greater than the ultimate moment due to loading that occurs with a value of 66912.64 kN.m.

Keywords
Bridge Design, Bridge Upper Structure, Composite Box Girder

1. Introduction

Kalimantan is known as the island of a thousand rivers, in Kalimantan there are also many coal mines. In the process of mobilizing coal on mine hauling roads that intersect with river flows, it is necessary to have a bridge capable of carrying the traffic load from the mining truck. This study aims to plan the structure of the bridge with a composite box girder for coal mine trailer loads.

2. Methodology

The methods applied in the writing of this thesis uses literary study method and quantitative method, the study of literature is finding a theoretical basis that is relevant to the case study and quantitative stages of the research process using data in the form of numbers as an analysis tool.

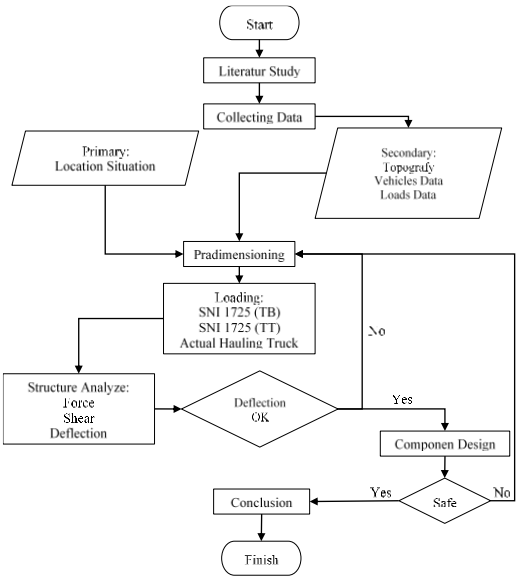

Figure 1. Flowchart of Research
Source: Data in Research, 2020

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2.1. Vehicles Data

In this case study, the mining transport vehicles used can be seen in Figure 2.

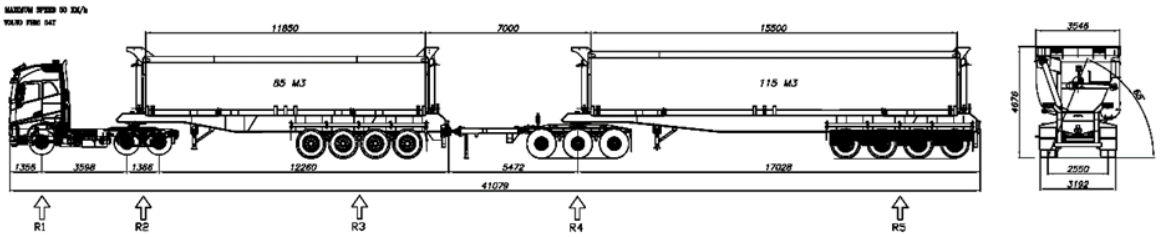

Figure 2. Hauling Truck
Source: Data in Research, 2020

2.2. Loads Data

In this case study, loads data from mining transport vehicles used can be seen in table 1.

Table 1. Loading Data

Description	R1	R2	R3	R4	R5	Total
Volvo FH16	6.013	4.997				11.010
SDT 85m3	693	6.291	20.516			27.500
Payload (coal 85m3)	2.328	21.140	48,782			72.250
Dolly				8.000		8.000
SDT 115m3				10.621	22.509	33.310
Payload (coal 115m3)				38.269	59.481	97.750
Gross Combination Weight	9.034	32.428	69.298	56.890	81.990	249.640

Source: Data in Research, 2020

2.3. Material Properties

In this case study, the materials used can be seen in table 2.

Table 2. Material Properti

Material	Grade
Concrete	K-400
Rebar < ø10mm	BJTP 24
Rebar > D13mm	BJTD 40
Steel	JIS G1306 SM 490 YB

Source: Data in Research, 2020

3. Result and Discussion

3.1. Section Proportion

In this case study, preliminary section property was created as shown in Figure 3.

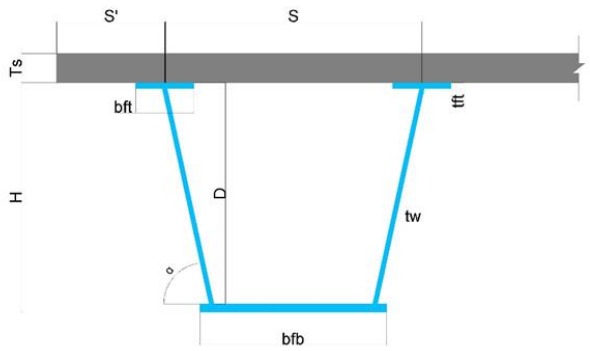

Figure 3. Preliminary Section Properti
Source: Data in Research, 2020

where,

H = 2200mm	D = 2150mm	S = 2800mm	α = 71°
tft = 25mm	tw = 20mm	tfb = 25mm	Ts = 250mm
bft = 400mm	bfb = 1500mm		

a. Web Proportion

Inspection of webs proportion is planned to be proportional to resist a bending, webs shall be proportioned such that:

D/t_w ≤150 eq. 6.10.2.1.1-1 Webs without longitudinal stiffener

D/t_w ≤300 eq. 6.10.2.1.2-1 Webs with longitudinal stiffener

However, webs than have larger D/t_w values than specified by equation are relatively inefficient, are likely to be more susceptible to distortion-induced fatigue.

2150/20=107,5≤150 OK! Webs without longitudinal stiffener

b. Flanges Proportion

Inspection of flanges proportion, flanges shall be proportioned such that:

b_f/〖2t〗_f ≤12 eq. 6.10.2.2.1-1 □ is partical upper limit to ensure the flanges will not distort excessively when welded to the web.

bf ≥D/6 eq. 6.10.2.2.1-2 □ limits this ratio to maximum value of 6

t_f ≥1,1t_weq. 6.10.2.2.1-2□ ensures than some resistant will be provided by the flanges against web shear buckling.

400/(2 .25)=8 ≤12 □ OK!

400 ≥2150/6=358,3 □ OK!

25 ≥1,1 .20=22 □ OK!

c. Modeling

Modeling of cross-sectional proportions that have been carried out can be seen in figure 4.

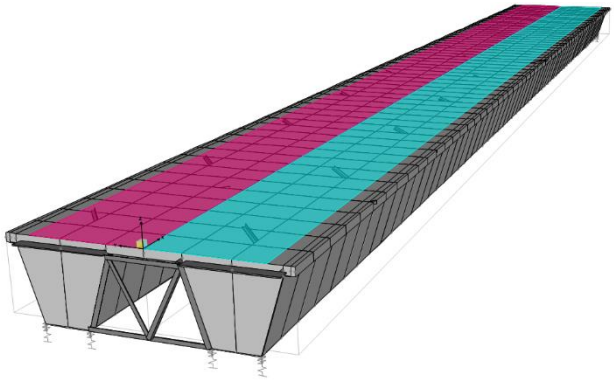

Figure 4. 3D Modeling U Composite
Source: Data in Research, 2020

d. Loading

Loading is carried out based on the applicable provisions of SNI 1725: 2016 with loads that can be seen in table 3.

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Table 3. Loading

Linier Static	Moving Load
Self Weigth (MS)	Lane Load (TD)
Additional Dead Load of Barrier (MA)	Truck Load (TT)
Additional Dead Load of Walkway (MA)	Braking Load (TB)
Additional Dead Load of Finishing Surface (MA)	Hauling Truck Load (TA)
Additional dead load of rainwater puddles (MA)	Pedestrian Load (TP)

Source: Data in Research, 2020

For the load combinations applied in each limit state can be seen in table 4.

Table 4. Load Combination

Kombinasi	MS	MA	TD	TT	TB	TP	TAk
Kuat 1a	1,3	2	1,8			1,8	
Kuat 1b	1,3	2		1,8		1,8	
Kuat 1c	1,3	2			1,8	1,8	
Kuat 1d	1,3	2				1,8	1,8
Kuat 2a	1,3	2	1,4			1,4	
Kuat 2b	1,3	2		1,4		1,4	
Kuat 2c	1,3	2			1,4	1,4	
Kuat 2d	1,3	2				1,4	1,4
Layan 1a	1	1	1			1	
Layan 1b	1	1		1		1	
Layan 1c	1	1			1	1	
Layan 1d	1	1				1	1
Layan 2a	1	1	1,3			1,3	
Layan 2b	1	1		1,3		1,3	
Layan 2c	1	1			1,3	1,3	
Layan 2d	1	1				1,3	1,3

Source: Data in Research, 2020

3.2. Research results

The results of research were obtained from the analysis process and literature study. The analysis process is carried out in the CSi Bridge software. The analysis process is carried out after all loads and load cases are in accordance with the loads acting on the bridge structure. Load case is used as a function used for loading analysis in a boundary state. So that the decisive moment is obtained at 66912.64 kN.m with a shear force of 4526.04 kN.

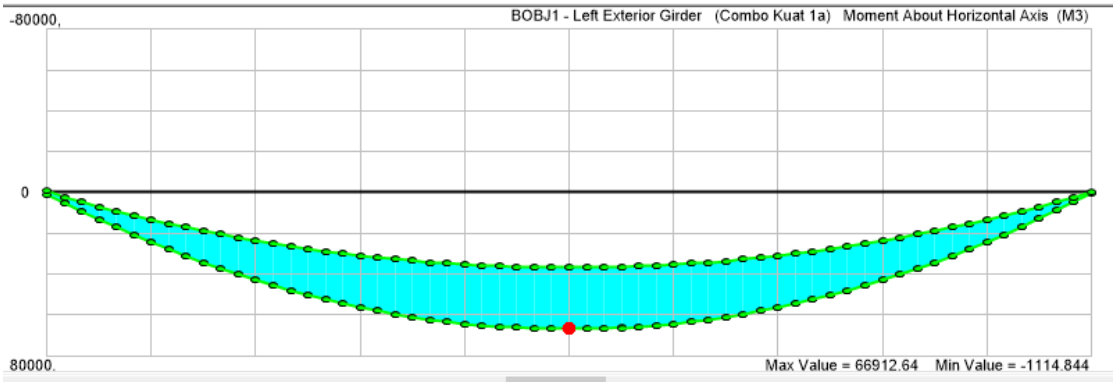

Figure 5. Ultimate Momen
Source: Data in Research, 2020

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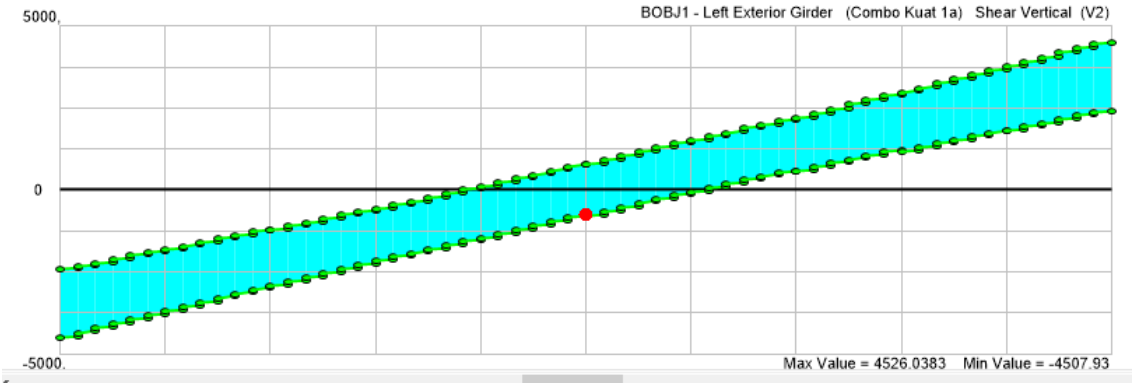

Figure 6. Ultimate Shear Force
Source: Data in Research, 2020

3.3. Flexure Design

The compact section on a straight bridge must satisfy the following requirements:

The yield strength of the flanges should not be more than 70 ksif_yf≤485 Mpa

Webs proportion shall satisfy of eq. 6.10.2.1.1-1 D/t_w ≤150,

The cross section shall satisfy of eq. 6.10.6.2.2-1 (2D_cp)/t_w ≤3,76 √(E/fy)

For straight bridges that do not meet the above requirements and curved bridges even though they meet the requirements, they must be considered non-compact cross-sections.

At the strength limit state, the compact section shall satisfy requirment:

M_u+1/3 f_l S_xt ≤ ϕ_f M_n Eq. 6.10.7.1.1-1

M_u≤ 〖ϕ_f M〗_n = 66 912,64 kN.m ≤ 0.9 x 87 617,93=78 856,13 kN.m OK!

This equation is an interaction equation that adds the effect of lateral buckling to the tensile wing, which is represented by the lateral bending stress elastic calculated wings, combined with ultimate bending moment.

Nominal Flexural Resistance eq. 6.10.7.1.2 can be determined if:

D_p≤0.1D_t then

Mn = Mp Eq. 6.10.7.1.2-1

otherwise, then

Mn = Mp (1,07-0,7 D_p/D_t) Eq. 6.10.7.1.2-2

Mn = 112 602,9 (1,07-0,7 1021,6/2450)

Mn = 87 617,93 kN.m

For the value of the positive plastic moment, the composite cross section can be divided into 7 cases depending on the amount of PNA,

M_p=P_w/2D [〖Y ̅〗 ^2+(D- Y ̅)^2]+[P_s d_s+ P_rt d_rt+ P_rb d_rb+ P_c d_c+ P_t d_t]

M_p=112602,9 kN.m

Where,

Y ̅=(D/2) [(P_t- P_c- P_s- P_rt- P_rb)/P_c +1] = 746,6mm

3.4. Shear Design

At the strength limit state, the straight or curves webs shall satify:

V_u ≤ ϕ_v V_n Eq. 6.10.9.1-1

V_u ≤ φ_v V_n 4526,91 kN ≤ 8192,79 kN OK!

The nominal shear resistance of the body plate without stiffening shall be taken as the shear resistance or bending resistance as follows:

V_n= V_cr=C V_p Eq. 6.10.9.2-1

where,

V_p=0,58 . 〖fy〗_w . 〖Dt〗_w Eq. 6.10.9.2-2

V_p=0,58 .365 .2150 .20=9103,1 kN

for the ratio value (C) can be determined by the specifications below:

if D/t_w ≤1.12 √(Ek/〖fy〗_w) then,

C = 1,0 Eq. 6.10.9.3.2-4

if 1.12 √(Ek/〖fy〗_w) < D/t_w ≤1.40 √(Ek/〖fy〗_w) then,

C=(1.12)/(D/t_w) √(Ek/〖fy〗_w) Eq. 6.10.9.3.2-5

if D/t_w ≤1.40 √(Ek/〖fy〗_w) then,

C=(1.57)/〖(D/t_w)〗^2 (Ek/〖fy〗_w) Eq. 6.10.9.3.2-6

with coefficient value:

k=5+ (5)/〖(d_0/D)〗^2 Eq. 6.10.3.2-7

4. Conclusion

Based on the economic span of the study location, can use a 60m span composite girder with the working load is a linear static load and a moving load. The proportion of the cross-section obtained to carry the load with the nominal resistance moment value of 78856.14 kN.m which is still greater than the ultimate moment that occurs due to loading of 66912.64 kN.m

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Factors Affecting Delays in Luwansa Manado Hotel Project

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Abstract

Building construction in Indonesia from year to year is growing, especially in the construction world. The increasing number of construction service providers in recent times should be offset by cost savings, quality in accordance with standards and also project time management. In Indonesia especially in Manado city there are many hotel developments, one of which is the construction of Hotel Luwansa manado. Acting as the main contractor (Main Contractor) of PT. Recta Construction, as the winner of the tender of the project. The construction of Hotel Luwansa Manado is one of the hotel developments not far from Manado City Beach which has 1 Tower, covering 10 floors, roof top, and 2 basements. At the time of implementation of the project one of the sub contractors had already started the foundation work in July 2019 and should have been completed in October 2019. However, the design of the foundation work on the project retreated to January 2020, due to design changes and resulted in the addition of foundation work at The Luwansa Hotel Project Manado. The method carried out in this study is the collection of data through questionnaires distributed to several respondents. The method of analysis performed is quantitative descriptive. The quantitative approach is research that focuses on hypothesis testing, the data used must be measured, and produce a generalized conclusion. This method uses (analysis tools) inference statistics (inconclusive). This method of analysis aims to describe the delay in construction work of Hotel Luwansa Manado building. From the analysis using the SPSS program there are five dominant variables namely X18 of 0.270,X16 of 0.239,X24 of 0.212,X17 of 0.172,and X27 of 0.104.

Keywords:
Analysis of questionnaire data, Project delay, SPSS program.

1. Introduction

1.1. Background

Building construction in Indonesia from year to year is growing, especially in the construction world. The increasing number of construction service providers in recent times should be offset by cost savings, quality in accordance with standards and also project time management. In Indonesia especially in Manado city there are many hotel developments, one of which is the construction of Hotel Luwansa manado. Acting as the main contractor (Main Contractor) of PT. Recta Construction, as the winner of the tender of the project.

The construction of Hotel Luwansa Manado is one of the hotel developments not far from Manado City Beach which has 1 Tower, covering 10 floors, roof top, and 2 basements. At the time of implementation of the project one of the sub contractors had already started the foundation work in July 2019 and should have been completed in October 2019 (Mochtar, 2019). However, the design of the foundation work on the project retreated to January 2020, due to design changes and resulted in the addition of foundation work at The Luwansa Hotel Project Manado. Furthermore, during the process of carrying out the work of the building structure resulted in the work of the main contractor was hampered. To overcome the constraints on the initial implementation of structure work such as lack of HR efficiency, waiting for the structural work of sub contractors, changes in work picture, material entrant, and so on. The role of the main contractor to complete the work in time will be the added value of the owner of the project to the main contractor, by accelerating its implementation.

Delays in the implementation of construction projects can be overcome by accelerating implementation in order to achieve the target plan. But in the decision to accelerate the implementation of the work should certainly pay attention to the financing factor so that the expected result is the minimum cost without ignoring the quality according to the desired standards (Male, 2017). In the case of this construction project is the delay of work that will adversely affect the project. Therefore, researchers here are interested in discussing the identification of the factors causing the delay in the construction project's work, and how to address the delays caused by the factors that are the cause of the delay in the project.

1.2. Identify Problems

Based on the background that the author has described, the identification of problems based on observations in the field is:

a. Kslowed the implementation of structural work on the Luwansa Manado Hotel project in the implementation process was delayed at the beginning of implementation with a delay of 22.2% from the original plan, supposed to start in October backwards to January. With a loss of 18.61 % of the contract value.
b. The implementation of time management on the structure work on the Luwansa Manado Hotel project was not suitable, resulting in delays in the construction of the structure.

1.3. Problem Formulation

From background writing and identification of the above problems, the formulation of problems related to this research includes:

a. What are the dominant factors that caused the delay in the work of the Luwansa Manado Hotel project structure?
b. How is the strategy to overcome structural work delays on the Luwansa Manado Hotel project project?

1.4. Intent And Purpose

The intent and purpose of writing this Final Task are:

a. Knowing what dominant factors caused the delay in the work of the Luwansa Manado Hotel project structure?
b. Knowing what strategies to be able to overcome structural work delays on the Luwansa Manado Hotel project project?

2. Methodology

Preparation of Research Water Diagram is:

1. Identify problems and formulation of problems: at this stage researchers conduct research by looking for objects and problems that occur at Hotel Luwansa Manado,then formulate the problem as a guideline in conducting research.
2. Literature studies and data collection: researchers conduct literature studies that examine several journals and articles to find out which studies have been conducted in the past related to the meticulous, variables and factors studied, the procedures that have been applied, the results and obstacles found in the research. Researchers also conducted primary data collection, by disseminating questionnaires to several respondents.
3. Preparation of Questionnaire :
    a. Phase I Questionnaire: Preparation of phase l questionnaire intended to ask experts to review questionnaires that have been compiled by researchers.
    b. Phase II Questionnaire: The dissemination of phase 2 questionnaires was given to several prospective respondents.
    c. Phase III questionnaire: At this stage the researchers conducted the dissemination of questionnaires given to respondents involved in the work of Hotel LuwansaManado.
    d. Questionnaire data input: Here the researchers re-collected the questionnaire that the respondents had filled out to be further analyzed.
4. Data Analysis Problem :
   To analyze the data of the questionnaire researchers used quantitative descriptive analysis methods with the help of the SPSS program.
5. Data processing and discussion:
   After the results of the questionnaire are analyzed then discuss with experts about the results of the analysis of questionnaires that have been done, so that experts provide recommendations.
6. Data Analysis Problem 2 :
   To analyze the data for the formulation of problem 2.
7. Preparation of Phase IV Questionnaire:
   The dissemination of the phase IV questionnaire by interviewing experts mengenai analsisisresults from the questionnaire that has been conducted, so that mem expertsprovide recommendations that include preventive andcorrective measures on variables that affect the delay in construction project work.
8. Conclusions and Suggestions :
   At this stage, researchers are providing conclusions from the results of the study on the causes of delays in building construction work in order for the researchers to further develop.

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3. Results and Discussion

3.1 Introduction

This chapter describes the analysis and asil of the dominant factors that affect the delay of the Luwansa Manado HotelProject. Data collection begins with the dissemination of questionnaires to experts, followed by the dissemination of pilot survey questionnaires on samples from populations and then the dissemination of questionnaires to respondents. The method used in analyzing such data is statistical data analysis..

3.2 Analysis With Spss Program

3.2.1 Validity and Reability Test

Table 3.1 Internal Validity Test Results

Variable	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Conclusion	R Table
X1	113.98	128.295	0.676	0.897	Valid	0.294
X2	114.76	133.416	0.202	0.908	Tidak Valid	0.294
X3	113.93	132.518	0.396	0.901	Valid	0.294
X4	113.93	132.518	0.495	0.900	Valid	0.294
X5	113.96	129.998	0.545	0.899	Valid	0.294
X6	114.11	127.965	0.637	0.897	Valid	0.294
X7	114.56	131.798	0.407	0.901	Valid	0.294
X8	114.33	132.182	0.302	0.904	Valid	0.294
X9	114.22	127.404	0.716	0.896	Valid	0.294
X10	114.51	131.301	0.305	0.905	Valid	0.294
X11	114.96	128.953	0.520	0.899	Valid	0.294
X12	113.98	127.886	0.618	0.897	Valid	0.294
X13	114.13	129.118	0.624	0.897	Valid	0.294
X14	114.04	134.043	0.436	0.901	Valid	0.294
X15	114.24	130.462	0.467	0.900	Valid	0.294
X16	114.36	125.916	0.789	0.894	Valid	0.294
X17	114.42	131.522	0.449	0.900	Valid	0.294
X18	114.24	132.916	0.260	0.905	Tidak Valid	0.294
X19	114.42	132.840	0.434	0.901	Valid	0.294
X20	114.47	131.391	0.526	0.899	Valid	0.294
X21	114.02	133.249	0.407	0.901	Valid	0.294
X22	114.27	132.745	0.360	0.902	Valid	0.294
X23	114.18	128.968	0.584	0.898	Valid	0.294
X24	114.53	128.164	0.602	0.897	Valid	0.294
X25	114.00	134.500	0.402	0.901	Valid	0.294
X26	115.16	129.180	0.460	0.900	Valid	0.294
X27	114.67	130.727	0.445	0.900	Valid	0.294
X28	114.62	125.195	0.699	0.895	Valid	0.294

(Source : Statistical Software Processed)

Table 3.2 Realization Test Results

Cronbach's Alpha	N of Items
0.903	28

(Source : Statistical Software Processed)

3.2.2 Deskriptif analysis

Table 3.3 Descriptive Test Results

Variable	N	Minimum	Maximum	Mean
X1	45	2	5	4.58
X3	45	2	5	4.62
X4	45	3	5	4.62
X5	45	3	5	4.60
X6	45	2	5	4.44
X7	45	2	5	4.00
X8	45	1	5	4.22
X9	45	2	5	4.33
X10	45	1	5	4.04
X11	45	2	5	3.60
X12	45	2	5	4.58
X13	45	2	5	4.42
X14	45	3	5	4.51
X15	45	3	5	4.31
X16	45	3	5	4.20
X17	45	3	5	4.13
X19	45	3	5	4.13
X20	45	3	5	4.09
X21	45	3	5	4.53
X22	45	3	5	4.29
X23	45	3	5	4.38
X24	45	2	5	4.02
X25	45	3	5	4.56
X26	45	2	5	3.40
X27	45	1	5	3.89
X28	45	3	5	3.93

(Source : Statistical Software Processed)

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3.2.3 External Validation (Correlation Test)

Table 3.4 Correlation of Variable Relationships X and Y

Variable	N	*Correlation Coefficient*	Sig. (2-tailed)
X1	45	.705**	0.0000
X3	45	.478**	0.0009
X4	45	.522**	0.0002
X5	45	.552**	0.0001
X6	45	.702**	0.0000
X7	45	.599**	0.0000
X8	45	.544**	0.0001
X9	45	.750**	0.0000
X10	45	.488**	0.0007
X11	45	.552**	0.0001
X12	45	.671**	0.0000
X13	45	.609**	0.0000
X14	45	.478**	0.0009
X15	45	.499**	0.0005
X16	45	.796**	0.0000
X17	45	.518**	0.0003
X19	45	.457**	0.0016
X20	45	.532**	0.0002
X21	45	.499**	0.0005
X22	45	.447**	0.0021
X23	45	.578**	0.0000
X24	45	.655**	0.0000
X25	45	.421**	0.0039
X26	45	.479**	0.0009
X27	45	.506**	0.0004
X28	45	.754**	0.0000

(Source : Processed Results Software processed statistical data)

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Table 3.5 Variables with high correlation

Variable	Descriptive
X1	Perubahan design by Owner.
X3	Imade a decision.
X4	Perubahan material oleh owner.
X5	Poor communication between owner and planner on planning.
X6	Communication between consultants and contractors.
X7	Preparation of work schedules and revisions by consultants while construction is underway.
X8	Changes in technical specifications of work items
X9	Understaffing and trained management to support construction implementation
X10	Projectinitial planning
X11	Waiting for permission for materialcontrol.
X12	Material Shortage
X13	Material changes to shapes, functions, and specifications.
X14	Delay sending materials
X15	Difficult location.
X16	Environmental sustainability.
X17	Inappropriate booking times
X19	Incompetent workforce.
X20	Workforce capabilities.
X21	Financial availability during implementation
X22	Late payment process by Owner.
X23	National economic situation
X24	Fluctuations in rupiah value against the dollar
X25	Late payment of the owner.
X26	Social and cultural factors
X27	The effect of rain on construction activities.
X28	The effect of environmental security on project development.
Variable	Descriptive
X1	Perubahan design by Owner.
X3	Imade a decision.
X4	Perubahan material oleh owner.
X5	Poor communication between owner and planner on planning.
X6	Communication between consultants and contractors.
X7	Preparation of work schedules and revisions by consultants while construction is underway.
X8	Changes in technical specifications of work items
X9	Understaffing and trained management to support construction implementation
X10	Projectinitial planning
X11	Waiting for permission for materialcontrol.
X12	Material Shortage
X13	Material changes to shapes, functions, and specifications.
X14	Delay sending materials
X15	Difficult location.

Variable	Descriptive
X16	Environmental sustainability.
X17	Inappropriate booking times
X19	Incompetent workforce.
X20	Workforce capabilities.
X21	Financial availability during implementation
X22	Late payment process by Owner.
X23	National economic situation
X24	Fluctuations in rupiah value against the dollar
X25	Late payment of the owner.
X26	Social and cultural factors
X27	The effect of rain on construction activities.
X28	The effect of environmental security on project development.

*(*Source : Own Processed Products 2020)

3.2.4 Regression Analysis

Table 3.6 Entered/Removed Variables

Model	Variables Entered	Variables Removed	Method
1	X16		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	X18		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	X24		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	X17		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	X27		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

(Source : Processed Results Software processed statistical data)

Table 3.7 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.669[a]	0.447	0.435	0.412
2	.851[b]	0.724	0.711	0.294
3	.910[c]	0.828	0.816	0.235
4	.937[d]	0.877	0.865	0.201
5	.945[and]	0.892	0.879	0.191

a. Dependent Variable: y

b. Predictors: (Constant), X16

c. Predictors: (Constant), X16, X18

d. Predictors: (Constant), X16, X18, X24

e. Predictors: (Constant), X16, X18, X24, X17

f. Predictors: (Constant), X16, X18, X24, X17, X27

(Source : Processed Results Software processed statistical data)

Table 3.8 Anova Table / Test F

Model		Sum of Squares	df	Mean Square	F	It's getting you out of here
1	Regression	5.906	1	5.906	34.821	.000[b]
	Residual	7.294	43	0.170		
	Total	13.200	44			
2	Regression	9.560	2	4.780	55.148	.000[c]
	Residual	3.640	42	0.087		
	Total	13.200	44			
3	Regression	10.934	3	3.645	65.933	.000[d]
	Residual	2.266	41	0.055		
	Total	13.200	44			
4	Regression	11.581	4	2.895	71.527	.000[and]
	Residual	1.619	40	0.040		
	Total	13.200	44			
5	Regression	11.779	5	2.356	64.635	.000[f]
	Residual	1.421	39	0.036		
	Total	13.200	44			

(Source : Processed Results Software processed statistical data)

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Table 3.9 Table *of Coefficients and* Test T

Model		Unstandardized Coefficients		Standardized Coefficients	t	It's getting you out of here
		B	Std. Error	Beta		
1	(Constant)	2.167	0.350		6.190	0.000
	X16	0.484	0.082	0.669	5.901	0.000
2	(Constant)	0.976	0.310		3.148	0.003
	X16	0.470	0.059	0.650	8.015	0.000
	X18	0.290	0.045	0.526	6.492	0.000
3	(Constant)	0.591	0.259		2.277	0.028
	X16	0.357	0.052	0.493	6.850	0.000
	X18	0.261	0.036	0.474	7.225	0.000
	X24	0.245	0.049	0.363	4.986	0.000
4	(Constant)	0.272	0.236		1.155	0.255
	X16	0.308	0.046	0.426	6.676	0.000
	X18	0.251	0.031	0.456	8.099	0.000
	X24	0.199	0.044	0.294	4.550	0.000
	X17	0.182	0.045	0.251	3.999	0.000
5	(Constant)	0.064	0.241		0.266	0.791
	X16	0.239	0.053	0.330	4.507	0.000
	X18	0.270	0.030	0.490	8.848	0.000
	X24	0.212	0.042	0.314	5.069	0.000
	X17	0.172	0.043	0.238	3.982	0.000
	X27	0.104	0.045	0.158	2.329	0.025

(Source : Processed Results Software processed statistical data)

3.3 Final Expert Validation

Table 4.1 Final Validation Results (Expert I)

Variable	Description	Statement	Conclusion
X16	Environmental sustainability	Already	Agree
X18	Labor shortage	Already	Agree
X24	Fluctuations in rupiah value against the dollar	Already	Agree
X17	Inappropriate booking times	Already	Agree
X27	The effect of rain on construction activities	Already	Agree

(Source : Self-Processed Products 2020)

Table 4.2 Delay Factor Handling Strategies (Expert I)

Variable	Statement	Opinion
X16	Agree	Penggalangan coordination with the environment and police officers.
X18	Agree	Accelerate the labor recruitment process through recommendations from project employees under certain conditions.
X24	Agree	Set the unit price at the beginning with anticipation of a dollar increase.
X17	Agree	Ensuring and selecting suppliers who have good credibility in the delivery of materials.
X27	Agree	Accelerate implementation time with the addition of manpower.

(Source : Self-Processed Products 2020)

Table 4.3 Final Validation Results (Expert II)

Variable	Description	Statement	Conclusion
X16	Environmental sustainability	Already	Agree
X18	Labor shortage	Already	Agree
X24	Fluctuations in rupiah value against the dollar	Already	Agree
X17	Inappropriate booking times	Already	Agree
X27	The effect of rain on construction activities	Already	Agree

(Source : Self-Processed Products 2020)

Table 4.4 Delay Factor Management Strategies (Expert II)

Variable	Statement	Opinion
X16	Agree	Increase supervision of project areas through the implementation of patrols in order to reduce the risk of delays arising from people not interested in entering the construction project area (scavengers, children, grass seekers, etc.)
X18	Agree	Accelerate the labor recruitment process through recommendations from project employees.
X24	Agree	Set the unit price at the beginning with anticipation of a dollar increase.
X17	Agree	Take into account the time to know the material will run out in storage.
X27	Agree	Accelerate implementation time with the addition of manpower.

Source : (Self-Processed Products 2020)

Table 4.5 Final Validation Results (Expert III)

Variable	Description	Statement	Conclusion
X16	Environmental sustainability	Already	Agree
X18	Labor shortage	Already	Agree
X24	Fluctuations in rupiah value against the dollar	Already	Agree
X17	Inappropriate booking times	Already	Agree
X27	The effect of rain on construction activities	Already	Agree

Source : (Self-Processed Products 2020)

Table 4.6 Delay Factor Management Strategies (Expert III)

Variable	Statement	Opinion
X16	Agree	Ifthere are reports of loss, security should be at least able to make Event News to be reported to the boss..
X18	Agree	Accelerate the labor recruitment process.
X24	Agree	Set the unit price at the beginning with anticipation of a dollar increase.
X17	Agree	Management of order time by paying attention to stock material in storage.
X27	Agree	Accelerate implementation time with the addition of manpower.

(Source : (Self-Processed Products 2020)

4. Conclussion and Suggestions

4. 1 Conclusion

Based on the results of processing and analysis of data that has been done in previous chapters, it can be drawn some conclusions of the dominant cause of delays in the construction project of Hotel Luwansa Manado..

1. The dominant factor is the delay in the construction project work of Hotel Luwansa Manado, namely:

Table 4.7 Analysis Results

Variable	Causes of Delay	Slope/Coefficient Estimate
X18	Labor shortage	0.270
X16	Environmental sustainability	0.239
X24	Fluctuations in rupiah value against the dollar	0.212
X17	Inappropriate booking times	0.172
X27	The effect of rain on construction activities	0.104

(Source : (Self-Processed Products 2020)

2. Based on the analysis that has been done in this study that the factor that is very influential to the delay of work on the Project Hotel Luwansa Manado is the Labor Factor (X18) by 27.0%. Strategies to reduce work delays are by approaching each cause of delays. Other strategies to overcome delays in Hotel Luwansa Manado project are as follows:
    a. Accelerate the labor recruitment process through recommendations from project employees.
    b. Increase the supervision of the project area through the implementation of patrols in order to reduce the risk of delays arising from people who are not interested in entering the construction project area (scavengers, children, grass seekers, etc.).
    c. Set the unit price at the beginning with anticipation of a dollar increase.
    d. Ensuring and selecting suppliers who have good credibility in the delivery of materials.

4. 2 Suggestions

From the results of research, analysis and discussion and conclusions taken, it can be suggested:

1. From the results of the author's study on the delay in the implementation of the project. The authors found that late work was influenced by 4 (four) dominant variables, should contractors pay attention to the 4 (four) dominant variables.
2. Contractors need to coordinate more with the field supervisor in order to be more careful in looking at the progress of the work, so as to suppress or speed up the completion time of the work.

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Concrete Durability by using Ground Granulated Blast Furnace Slag as A Cement Substitution Against Sulfuric Acid and Chloride Penetration

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Abstract

It seems that improvements in cement production technology couldn't be expected to suppress carbon dioxide production significantly. Replacement of some parts of cement in the concrete manufacturing process, or in total replacing them with other more environmentally friendly materials becomes a more promising choice. Along with the increasing demand of concrete to serve the needs of construction in Indonesia is growing as well as innovations developed in the manufacture of concrete. One of them is the use of used materials or waste that can be utilized as add material or substitute cement as an alternative ingredient in concrete mixture. The purpose of this research is to find out the durability of concrete with substitution of Ground Granulated Blast Furnace Slag (GGBFS) against the penetration of sulfuric acid (H_2SO_4), the penetration of natrium chloride (NaCl) which also review the results of workability, change in density, into the penetration of sulfuric acid and compressive strength. The more the use of ground granulated blast furnace slag (GGBFS), the stronger it is to withstand the penetration of natrium chloride (NaCl). The average concrete density increased by 0.40%, the biggest change was at TM GGBFS 80% by 0.55%. With or without the use of ground granulated blast furnace slag (GGBFS) in the mixture of reinforced concrete acid sulfate (H_2SO_4) cannot enter into the concrete reviewed from the results of the titration Phenolphthalein is $C_{20}H_{14}O_4$ (pH indicator) the entire concrete surface has been cut in magenta color (base or pH > 8.3). The use of ground granulated blast furnace slag (GGBFS) in the optimum concrete mixture is able to withstand the penetration of sulfuric acid (H_2SO_4) and the penetration of natrium chloride (NaCl) at the age of 14 days with the substitution of 80% GGBFS which is reviewed from the results of compressive strength concrete.

Keywords:
Density, Durability, GGBFS, High quality concrete

1. Introduction

The development of concrete technology in achieving the objectives of environmentally friendly concrete with the improved durability capacity is currently being sought in various kinds of research. Concrete is a mixture of Portland cement or other hydrolic cement, smooth aggregate, coarse aggregate, and water with or without additives or admixture, (Badan Standarisasi Nasional, 2013). The advantages of concrete as a construction material include strong high press, can follow the shape of the building or mold. Another thing that underlies the selection and use of concrete as construction material is the effectiveness factor and efficiency level. Good quality concrete has some advantages including high quality concrete the ability to withstand the environmental conditions of abrasion, weather (hot, cold, sunlight, rain) or the process of the other. Concrete also has some disadvantages, namely weak to strong tensile, inflate and shrink when the temperature changes occur, it is difficult to perfectly waterproof, and is ducking (Tjokrodimuljo, 1996).

Lately, cement and concrete industries are increasingly highlighted, especially by environmental enthusiasts. This is due to carbon dioxide emissions, the largest component of greenhouse gases, resulting from the calcinous process of lime and coal burning. This environmental issue seems to be playing an important role in relation to the issue of sustainable development in the future. In the production of a ton of Portland cement, it will be produced about a ton of carbon dioxide gases released into the atmosphere. From 1995 years of data on cement production in the world recorded at 1.5 billion tonnes, it means the cement industry is releasing 1.5 billion tonnes of carbon dioxide into the wild.

According to the International Energy Authority: World Energy Outlook, the amount of carbon dioxide generated in 1995 is 23.8 billion tonnes. The figure indicates that the production of Portland cement contributes seven percent of the total carbon dioxide produced by various sources. It seems that this proportion will

continue to persist or even increase in accordance with the increase of cement production if there is no meaningful change in cement production technology or acquired cement substitute material. In 2010, it was estimated that the total cement production in the world reached 2.2 billion tonnes. The phenomenon causes the emergence of the desire to seek other materials that are not an unforeseen natural resource. It is the case that encourages researchers to find other materials that can be used to replace cement. Such material should have properties such as or at least similar to cement, known as cementitious material. Referring to the amount of cement industry donations to total carbon dioxide emissions, it is necessary to immediately be able to reduce the number of cement production that pollutes this environment. It seems that improvements in cement production technology could not be expected to suppress carbon dioxide production significantly. Replacement of some parts of cement in the concrete manufacturing process, or in total replacing them with other more environmentally friendly materials becomes a more promising choice.

Along with the increasing demand of concrete to serve the needs of construction in Indonesia is growing as well as innovations developed in the manufacture of concrete. One of them is the use of used materials or waste that can be utilized as add material or substitute cement as an alternative ingredient in concrete mixture.

Research on the utilization of waste in the manufacture of concrete has also been done before by some researchers. Some of them use fly ash waste, nickel slag, slag steel and copper slag. From previous research obtained several conclusions including the results of the use of slag on the substitution of concrete mixture K-225 is better in the range of 15% with a strong press reaches 25.34% higher than normal concrete and will decrease its strength when getting a substitution of more than 15% (Zainul, Djamaluddin and Anwar, 2018). The addition of copper slag 60% in lieu of a partially fine aggregate can increase the concrete press strength by 22% of the normal concrete and increase the tensile strength of concrete by 5.76% of the normal concrete (Karimah and Wahyudi, 2016). Compressive strength with substitution ground granulated blast furnace slag (GGBFS) 20% still according to the quality of the plan while the substitution of GGBFS 40% decreased by 7.95%, the substitution of GGBFS 60% decreased by 15.01% and substitution GGBFS 80% decreased by 19.17%. The decline is strong when it gets more than 20% of the subtitution. (Pratama, 2019).

In this case, the author developed the research previously done by Pratama (2019) using the Ground Granulated Blast Furnace Slag (GGBFS) as a material substitution of cement that is expected to produce a better concrete durability against sulfuric acid penetration and chloride penetration.The purpose of this research is to determine the effect of penetration of natrium chloride (NaCl) against changes in concrete density, the depth of sulfuric acid (H_2SO_4) in concrete as well as to determine the effect of the penetration of sulfuric acid (H_2SO_4) and natrium chloride (NaCl) against compressive strength.

2. Literature Review

2.1. Concrete

Concrete is a mixture of Portland cement or other hydraulic cement, smooth aggregate, coarse aggregate, and water, with or without additional mixed materials (admixture), (Badan Standarisasi Nasional, 2013). Concrete is one of the building materials used in the construction world. Because almost all work in the world of civil engineering use concrete as well as dam work, drainage, for rigid pavement and so forth. The higher the quality of concrete, the stronger a building. Factors that affect the quality of concrete are: the quality of materials used, cement type, water cement ratio, coarse aggregate gradation, the process of the implementation of concrete and concrete maintenance process.

2.2. Environmentally friendly Concrete

Almost all concrete basic meterial is a product of environmental damaging results. Need to be sought to minimize the impact of environmental damage caused, before there is concrete technology by replacing all materials used today the experts are developing polymer-based concrete material to replace the most applicative cement is to reduce the use of cement, the use of natural sand and water usage in concrete mixture without changing the quality, workability and durability. It can be said environmentally friendly concrete is concrete with a little cement, a little natural sand and a little water, without lowering the quality, workability, durability and performance (Khrisna P, 2014).

2.3. High quality concrete

Nawy (1985) declares concrete as a set of mechanical and chemical interactions of the constituent material. Neville, A.M. (1987) Give another understanding of concrete is reviewed from the diversity of the constituent material, namely materials made of various types of cement, aggregate and also pozolan materials, fly ash, high density, fiber, utilization of waste, and others. The SNI T-15-1990-03 (1991) defines concrete as a mixture between Portland cement or other hydraulic cement, smooth aggregate, coarse aggregate and water with or without additional mixed materials forming solid mass. Concrete class according to SNI T-15-1990-03 (1991) divided by its quality. According to the development of concrete technology is so rapid, according to Supartono

(1998) Apparently high concrete criteria also changed according to the development of the era, concrete is said to be high quality if the strength of power above 50 MPa and above 80 MPa is a very high quality concrete. Because almost all work in the world of civil engineering use concrete as well as dam work, drainage, for rigid pavement and so forth.

2.4. Aggregate

Aggregates are natural mineral granules that serve as filler materials in concrete mixtures. Aggregates can come from nature or from artificial aggregates. The use of aggregates in concrete can save the use of portland cement, produce great strength on concrete, reduce concrete hardening and control the workability of concrete mixing. Aggregate selection is an important part of concrete making (Tjokrodimuljo., 1986).

2.5. Water

In the manufacture of concrete, water is one important factor, since water can react with cement, which will be an aggregate binding paste. Water in the concrete mixture is required to react with cement, as well as a lubricant material between aggregate grains for easy concrete to be worked on and compacted. Another advantage of water is that it will together with a minute move to the surface of a fresh concrete stir that has just been sheathed (bleeding) into a mold that then becomes froth and is a thin layer called laitance. Thin membranes reduce the attachment between layers of concrete and are weak connecting fields (Tjokrodimuljo., 1986).

2.6. Ground Granulated Blast Furnace Slag (GGBFS)

GBFS/GBS Granulated Blast Furnace Slag/Granulated Blast Furnace Slag is a high furnace combustion residue is a non-metal product that is a granular material. The GBFS element consists mostly of lime, silica and alumina contained in iron when inserted into the furnace. The separation reaction between iron/steel and other elements occurs after being heated to a temperature of 1,600oC in the blast furnace that will convert it into liquid. When this liquid is cooled by dipping it in water then there will be a crystal called GGBFS. These Crystal granules can be used as aggregate substitutes. Finely ground GBFS is referred to as GGBFS/GGBS Ground Granulated Blast Furnace Slag/Ground Granulated Blastfurnace Slag. Currently the use of GGBFS as a portland cement substitution material with various advantages that it has is well known in the world even GBFS and GGBFS are freely traded. In Indonesia the use of this material has not been socialized well. In particular GBFS/GBS is still categorized as Waste B3 (Hazardous and Toxic Materials) where producers, containers, carriers and users /processing are limited by very strict regulations and licensing. Materials that include B3 waste when it has one or more explosive features, flammable, reactive, toxic, infectious, corrosive, etc.

GGBFS/GGBS or Semen Slag mainly contains calcium, aluminum and silica which have a chemical composition no different from natural ingredients including hydration materials such as Portland Cement. It is often used as a mixture of Portland Cement in the manufacture of concrete, mortar and others. This product mixture is referred to as cement blended. The variation of the GGBFS/GGBS mixture on Portland Cement makes it possible to optimize the special properties of concrete and mortar. GGBFS/GGBS exhibits the same adhesive quality as Portland Cement. It can therefore replace the Portland Cement function at a wide range with a specific mass comparison ratio. Various levels of GGBFS/GGBS replacement start from 10% to more than 70%. Some research results are generally used between 30%-50%. (Krakatau Semen Indonesia).

2.7. Chemical Admixture

Admixture is a material in the form of powder or liquid, which is added to the concrete mix during stirring, with the aim of changing the properties of the stir or concrete (Specifications of Additional Materials for Concrete, (SNI T-15-1990-03, 1991). Based on ACI (American Concrete Institute), the added materials are materials other than water, aggregate and hydraulic cement mixed in concrete or mortar added before or during stirring. The addition of added materials in a concrete or mortar mixture does not change the large composition of other materials, as the use of this added material tends to be a substitute or susbtitusi from within the concrete mixture itself. Because the goal is to improve or change the specific properties and characteristics of the concrete or mortar to be produced, the tendency of composition changes in weight-volume is not felt directly compared to the initial composition of concrete without added materials. The use of added materials in a concrete mixture should pay attention to applicable standards such as SNI (Indonesian National Standard), ASTM (American Society for Testing and Materials) or ACI (American Concrete Institute) and most importantly pay attention to the instructions in the trade product manual. In general, the added materials used in concrete can be distinguished into two, namely chemical admixture and additives.

2.8. Mix Design

There are several methods in the design of concrete mix design, including:

1. ACI Method (American Concreat Institute) Method, requires a mixture of concrete design taking into account the economic side by taking into account the availability of materials in the field, ease of work, as well as durability and strength of concrete work. The way ACI sees that with a certain aggregate size, the amount of percussic water will determine the consistency level of the concrete mixture that will ultimately affect workability.
2. Road Note Method No.4, this method of design is emphasized on the effect of aggregate gradation on ease of workmanship.
3. SK method. (SNI T-15-1990-03, 1991) / Current British Method (DoE), compiled by the British Departement of Environment in 1975 to replace the Road Note.4 in the UK. For conditions in Indonesia there has been an adjustment to the size of the strong variation of concrete press.
4. Trial and error mix method, trial and error method developed based on car methods ACI, Road Note No.4 and (SNI T-15-1990-03, 1991), after implementation and evaluation. This way of trying to get minimum pores or maximum concrete density means that the need for maximum fine aggregate to get minimum cement needs.

3. Method

The methods applied in this study are experimental methods. The free variable in this study is to reduce the use of cement in concrete mixture with substitution using GGBFS variation use GGBFS 0%, 60%, 70% and 80% which will be tested in the slump (workability), density changes due to the penetration of natrium chloride (NaCl), depth of sulfuric acid penetration (H_2SO_4) All the processes and procedures in conducting this research refer to SNI (Indonesian national Standards), ASTM (American Society for Testing and Material), as well as previous research journals. Before the implementation of concrete making, the preparation of materials will be used, further testing of materials to determine the quality and specifications of the material, as for the testing conducted for the aggregate physical testing is the moisture test (coloid content test), grading test (sieve analysis test), the specific gravity, absorption of (absorption), the test of clay lump test, the organic content of fine aggregate (organic impurities for fine aggregates) , the fill weight (density), the rough aggregate abrasion test (abration test) then carried out the mixture planning (mix design), after mixed composition obtained then a trial mix concrete with the test slump flow, the manufacture of test objects in the form of cylinders (diameter 10 cm, height 20 cm). In this chapter will be explained about the steps of testing, the manufacture of cylinder test objects, workability, the testing of the initial ikat (setting time), strong press (compressive strength), the penetration of sulfuric acid (H_2SO_4) and natrium chloride (NaCl) (durability).

4. Experimental Program

While the material used for Trial Mix include:

1. The fine aggregate is sourced from the quarry Ex. Jambi and Ex. Leles West Java.
2. The coarse aggregate size of 5-10 mm is sourced from the quarry Ex. Rumpin.
3. Semen OPC of type I of cement Gresik product.
4. Superplasticizer type F using P200 New product of PT. KKI Consol.
5. GGBFS from PT. Krakatau Semen Indonesia.
6. Sea water (NaCl).
7. Sulfuric acid (H_2SO_4).
8. Phenolftalein $C_{20}H_{14}O_4$ (pH indicator).

The mix design calculation is divided into 4 combinations:

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Table 1. TM 0%, TM 60%, TM 70%, TM 80%

Description	Unit	TM 0%	TM 60%	TM 70%	TM 80%
Target of Strength (f'c)	Mpa	50	50	50	50
Target of Slump	Cm	50-60	50-60	50-60	50-60
Water Cement Ratio (w/c)		0,293	0,293	0,293	0,293
Cement OPC Tipe I Gresik	Kgs/m³	460	184	138	92
GGBFS Ex. PT.KSI	Kgs/m³	0	276	322	368
Fine Aggregate Ex. Jambi	Kgs/m³	472	462	460	458
Fine Aggregate Ex. Leles	Kgs/m³	468	458	456	454
Coarse Aggregate Ex. Rumpin	Kgs/m³	844	850	851	852
Additive Type F	Ltr/m³	4,73	4,73	4,73	4,73
Water	Ltr/m³	135	135	135	135

5. Results And Discussion

Test results and analysis of concrete endurance research using Ground Granulated Blast Furnace Slag (GGBFS) as a cement substitution material against sulfuric acid penetration (H_2SO_4) and natrium chloride (NaCl). The results of material testing and analysis carried out include fine aggregate testing, crude aggregate testing, slump (workability) testing, initial set time testing, changes in concrete density due to the penetration of natrium chloride (NaCl), testing of $C_{20}H_{14}O_4$ Phenolftalein titration (pH indicator) after penetrating sulfuric acid (H_2SO_4), a compressive strength test due to penetration of sulfuric acid (H_2SO_4) and natrium chloride (NaCl).

Table 2. Titration Test Results

No.	Code	Visual & Age Penetration Sample		
		7 Days	14 Days	28 Days
1.	TM GGBFS 0%			
2.	TM GGBFS 60%			
3.	TM GGBFS 70%			
4.	TM GGBFS 80%			

According to table 2, after the cut is done titration Phenolphthalein is $C_{20}H_{14}O_4$ (pH indicator) It can be concluded that sulfuric acid (H_2SO_4) cannot enter into concrete is reviewed from the titration results of the entire magenta-coloured concrete surface (base or pH > 8.3).

Table 3. Concrete Density testing Results (NaCl penetration)

No.	Code	Early Density (kgs/m³)	Final Density (kgs/m³)	Density change (%)
1.	TM GGBFS 0%	2300	2308	0,35%
2.	TM GGBFS 60%	2229	2233	0,18%
3.	TM GGBFS 70%	2205	2216	0,53%
4.	TM GGBFS 80%	2325	2338	0,55%

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According to table 3, The average change in concrete density increased by 0.40%, the biggest change is in TM GGBFS 80% by 0.55%. This suggests that with the increasing number of substitutions of GGBFS, the stronger it is to withstand the penetration of natrium chloride (NaCl).

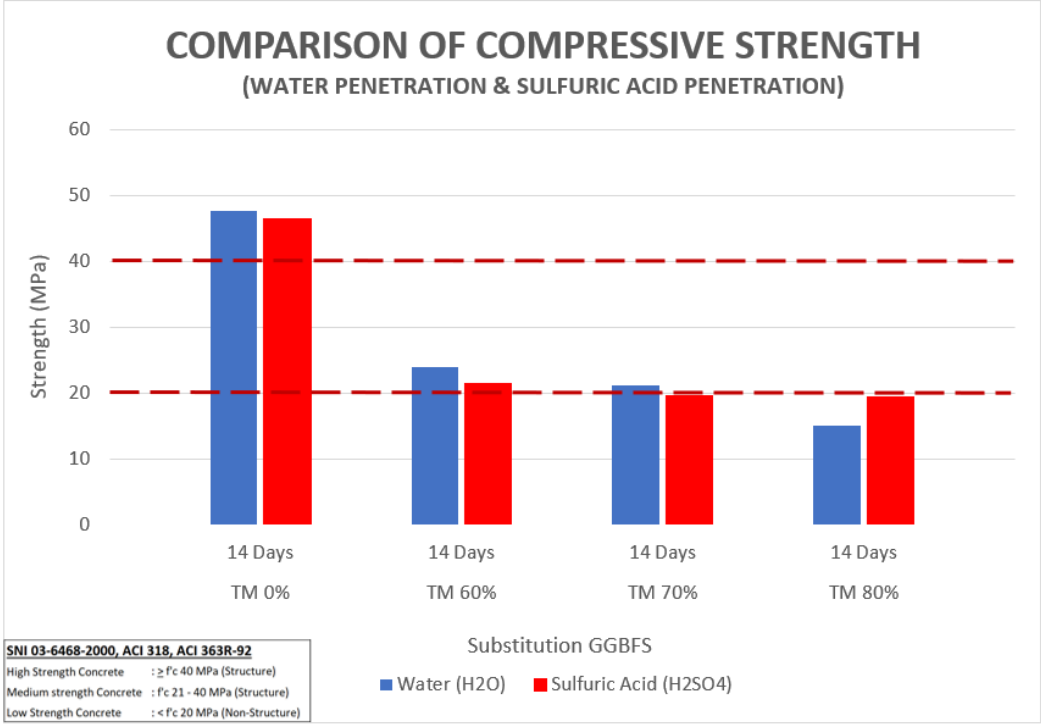

Figure 1. Comparison of Compressive Strength
(Water Penetration & Sulfuric Acid Penetration)

Based on Figure 1, it can be concluded that the use of 80% GGBFS substitution in a concrete mix of age 14 days is able to withstand the penetration of sulfuric acid (H_2SO_4) better than normal concrete (without substitution).

Table 4. Compressive Strength Concrete Result age 14 days

No.	Code	Age	(H_2O)	(H_2SO_4)
1	TM GGBFS 0%	14D	47,75	46,48
2	TM GGBFS 60%	14D	23,94	21,56
3	TM GGBFS 70%	14D	21,23	19,66
4	TM GGBFS 80%	14D	15,18	19,50

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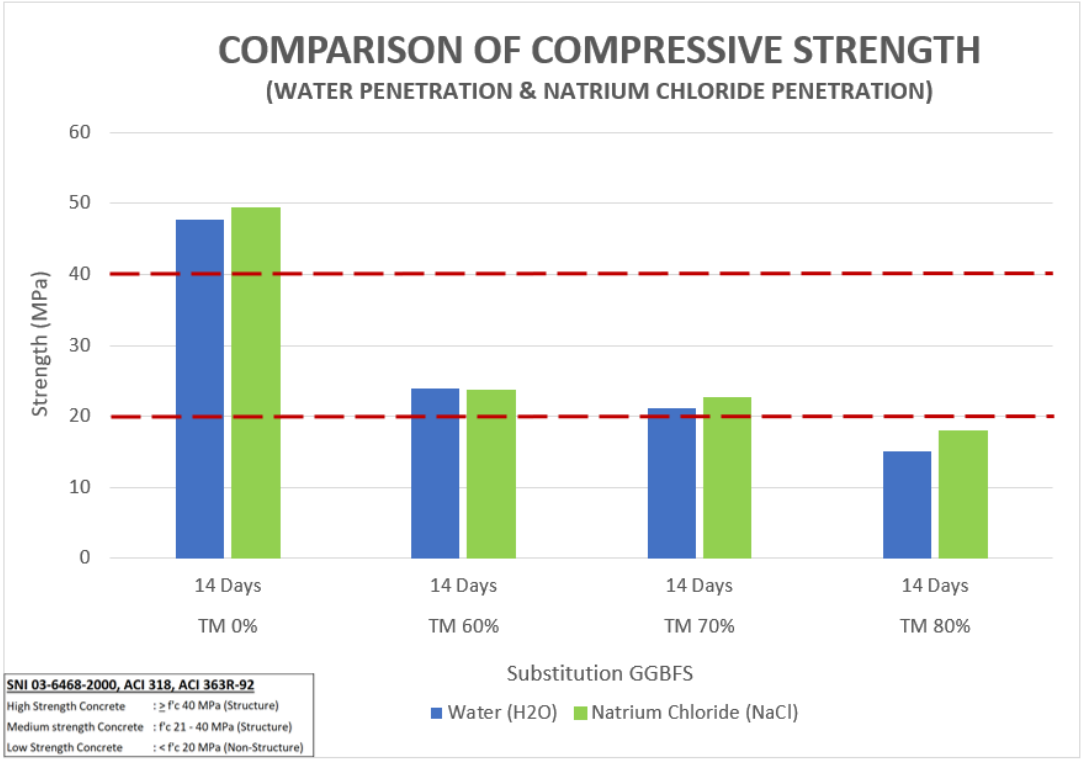

Figure 2. Comparison of Compressive Strength
(Water Penetration & Natrium Chloride Penetration)

Based on Figure 2, it can be concluded that the use of substitution GGBFS 70% and 80% in the concrete mixture of age 14 days is able to withstand the penetration of natrium chloride (NaCl) is better by 6.50% and 18.45% than normal concrete (without substitution).

Table 5. Compressive Strength Concrete Result age 14 days

No.	Code	Age	(H2O)	(NaCl)
1	TM GGBFS 0%	14D	47,75	49,39
2	TM GGBFS 60%	14D	23,94	23,62
3	TM GGBFS 70%	14D	21,23	22,61
4	TM GGBFS 80%	14D	15,18	17,98

6. Conclusion

The growing number of substitutions of Ground Granulated Blast Furnace Slag (GGBFS), the stronger the penetration of natrium chloride (NaCl). The average concrete density increased by 0.40%, the biggest change was at TM GGBFS 80% by 0.55%. With or without the use of substitution Ground granulated Blast Furnace slag (GGBFS) on the mixture of concrete acid sulphate (H_2SO_4) can not enter into the concrete is reviewed from the results of the titration Phenolphthalein is $C_{20}H_{14}O_4$ (pH indicator) all surfaces that have been cut in magenta color (base or pH > 8.3). Use of substitution Ground Granulated Blast Furnace Slag (GGBFS) in the optimum concrete mixture is able to withstand the penetration of sulfuric acid (H_2SO_4) and the penetration of natrium chloride (NaCl) at the age of 14 days with a substitution of 80% GGBFS which is reviewed from the results of compressive strength.

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Comparison of Erection Pierhead Segmental Method With Beam Lifter and Crawler Crane From of Time and Cost (JAPEK Elevated 2 Toll Project)

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Abstract

Jalan Toll Jakarta - Cikampek Elevated 2 is an elevated toll road built to connect the JABODETABEK area and its surroundings. One of the important jobs in the construction of the JAPEK Elevated 2 toll road is the segmental pierhead erection. This final project aims to determine the comparison of the time and cost aspects of the segmental pierhead erection method using beam lifters and crawler cranes, as well as to determine what factors influence the segmental pierhead erection method. Primary and secondary data were collected, then a comparative analysis of time and costs was carried out on the beam liftter and crawler crane methods by calculating the cycle time and the performance index of the tools. Furthermore, researchers used quantitative research by distributing questionnaires to respondents, namely all employees involved in the segmental pierhead erection process in the JAPEK Elevated 2 Toll project. The results of this study indicate that the segmental pierhead erection method using a crawler crane is faster but slightly more expensive than beam lifters. Then it is known the results of the analysis using SPSS software from the beam lifter tool, there are 17 independent variables that correlate to the dependent variable and the percentage of influence of the two variables is 53.8%. Meanwhile, from the crawler crane, there are 26 independent variables which correlate with the dependent variable and the percentage of influence of the two variables is 55.5%.

Keywords
Beam Lifter , Crawler Crane ,Segmental Erection Pierhead, ,SPSS

1. Preliminary

Construction development has increased very rapidly in terms of technology used, such as the development of technology in the construction of bridge structures and viaducts. The types of viaduct structures have developed in line with the history of human civilization, from simple types to complex types, with simple materials to modern ones. One of the developments in the construction of the current viaduct structure is the Jakarta - Cikampek Elevated Toll project 2. The application of technology to the relatively new viaduct structure is applied to the Jakarta - Cikampek Elevated Toll project 2. The Jakarta - Cikampek Elevated 2 toll road project along 36.4 KM stretches from Cikunir (KM 9 + 500) to West Karawang (KM 47 + 500). In the Jakarta - Cikampek Elevated 2 Toll project all structures are elevated consisting of borepile, pilecap, consisting of borepile, pilecap, column, pierhead, slab and asphalt and there are 2 main contractors working on the project, namely PT Waskita Karya Tbk from KM 9+ 500 to 28 + 000 and PT Acset Indonusa Tbk from KM 28 + 780 to 38 + 525. According to Dwi Laga (2019), one of the components of the viaduct structure is Pierhead, Pierhead is the Upper Structure holder which functions to distribute the load from the structure above to the Pier to the Borepile. The pierhead used in the Jakarta - Cikampek 2 Elevated toll road project, especially in the PT Acset Indonusa Tbk area, is a segmental pierhead which is divided into 3 segments. The segmental pierhead erection uses a beam liftter, one of the newest erection methods. However, from the segmental pierhead erection method there is another erection method that we can use in the Jakarta - Cikampek Elevated 2 Toll project, namely the segmental pierhead erection method using a crawler crane. Because the Jakarta - Cikampek Elevated 2 Toll project is one of the national strategic projects and is one of the acceleration projects, therefore in the PT Acset Indonusa Tbk area, 2 segmental pierhead erection methods were used using beam lifters and crawler cranes simultaneously to speed up time. completion of the project.

In this research, a main problem can be taken as follows:

1. How does the segmental pierhead erection method compare using beam lifters and crawler cranes in terms of time and cost?
2. What factors affect the time and cost of the segmental pierhead erection method using beam lifters and crawler cranes?

2. Research Methodology

In the process of working on this final project, the writer needs theoretical foundations that support the problems to be studied. Through literature studies, it is hoped that the author can increase knowledge and learn the basic theory that will be used as a reference.

Data collection is done by collecting data related to the problem being reviewed. Data collection was carried out on predetermined samples. These data are in the form of:

1. Secondary data: work images and project internal data
2. Primary data: direct field observations, interviews and documentation.

3. Method of Analysis

3.1.Time Analysis

The duration of work on the project is carried out by calculating the cycle time, which is the time needed to complete the production of one unit from start to finish. Furthermore, calculating productivity, namely the comparison between the results achieved (output) with all resources used (input).

Average / pierhead =(Total cycle time)/(Jumlah pierhead)
Tool productivity formula:
Tool Productivity Formula:
Productivity =60/(RATA-RATA PERPIERHEAD) X EFISIEnsi
Information:
Q = tool capacity
Cycle Time = cycle time (minutes)
Efficiency = efficiency tool

To determine the efficiency of the tool, if the working day is 8 hours while the effective working time is 6 hours, the efficiency of the tool is 6/8 or 0.75. After knowing the productivity of the tool, we can calculate the maximum number of girders to be lifted in one working day, which is 8 hours.

$$Durasi = produktivitas\ alat \times jam\ kerja\ perhari$$

3.2. Cost Analysis

The cost comparison of segmental pierhead erection will be done using the performance index of each tool.

$$\text{Index} = \frac{Total\ jam\ kerja}{Jam\ kerja\ normal}\ x\ \frac{Jml\ tenaga\ kerja/jml\ \ alat\ berat}{Jml\ komponen\ yang\ terpasang}$$

After knowing the index on each difference from the cost of work on each tool. The goal is to find out what heavy equipment is right for use in terms of cost.

$$Persentase\ Selisih,\% = \text{x } 100\frac{total\ biaya\ tertinggi}{total\ biaya\ terendah}$$

3.3. Validity test

The conditions that must be met by the validity test are, if the correlation coefficient> r table then the item is declared valid.

3.4. Reliability Test

Reliability test is used to find out how far the measurement results remain consistent when two or more measurements are made using the same measuring instrument. To see the reliability of each instrument used, th Cronbach's Alpha coefficient is used, namely

Table 1 Interpretation of R Value

No.	Ket	Score	Category
1	Alpha Value	0.00 - 0.20	Less reliable
2	Alpha Value	0.21 - 0.40	Rather reliable
3	Alpha Value	0.41 - 0.60	Fairly reliable
4	Alpha Value	0.61 - 0.80	Reliable
5	Alpha Value	0.81 - 1	Very Reliable

3.5. Correlation Test

Correlation test is used to determine the relationship between independent variables and the dependent variable or vice versa. Decision making can be seen from the significance value that must be achieved if the variables are correlated, namely the Sig. <0.05.

3.6. Regression Test

Linear regression test is useful for knowing the direction of the relationship between the independent variable and the dependent variable, whether each independent variable has a positive or negative relationship, and to predict the value of the dependent variable if the value of the independent variable has increased or decreased. The linear regression equation is:

$Y = a + bX$ ..... (1.1)

X = Independent variable
Y = Dependent variable
a = Constant
b = Regression coefficient

3.7. Determination Coefficient Test (R^2)

The coefficient of determination test is a tool to measure the ability of the model to explain the variation in the dependent variable. The value of the coefficient of determination is between 0 and 1. A small R^2 value means that the ability of the independent variable to explain the variation of the dependent variable is very limited, and vice versa (Achmad and Witiastuti, 2018).

4. Results and Discussion

The comparative aspects of segmental pierhead erection work in this study consist of time and cost aspects. Where the aspect of time is viewed from cycle time (cycle time) and calculates the productivity of the tool during segmental pierhead erection work using beam lifters or crawler cranes. While the cost aspect is carried out by calculating the performance index of each heavy equipment used in the segmental pierhead erection work on the Jakarta - Cikampek Elevated 2 toll road project (Mirnayani, 2016).

4.1. Job Time Segmental Pierhead Erection with Beam Lifter

The calculation of work duration and productivity of segmental pierhead erection with beam lifters is done by direct observation in the field. The number of pierhads to be observed is 5 or 5 spans.

Table 2. Key Cycle Time Cycle Erection Pierhead Segmental Work with Beam Lifter

Kode Waktu	Keterangan
t1	Pengaturan posisi *crawler crane* untuk *erection segment* 1
t2	*Checklist* kondisi *crawler crane*
t3	Pengangkatan *segment* 1 sampai atas *pier*
t4	Cek elevasi setelah itu install strand looping
t5	Stressing looping tendon
t6	Perakitan alat beam lifter sekaligus checklist kondisi beam lifter
t7	Pengangkatan beam lifter menggunakan crane ke atas segment 1
t8	Pengangkatan segment 2 (kanan & kiri)
t9	Install dan stressing strand segment 2 (kanan & kiri)
t10	Pengangkatan segment 3 (kanan & kiri)
t11	Install dan stressing strand segment 3 (kanan & kiri)
t12	t1+t2+t3+t4+t5+t6+t7+t8+t9+t10+t11

The results of recording the cycle time of segmental pierhead erection work using a beam lifter can be seen in the following table:

Table 3. Cycle Time of Segmental Pierhead Erection Pek with Beam Lifter at Span 1

Time Code	Cycle Time (Minutes) Span 1
t1	18.46
t2	7.29
t3	28.32
t4	8.53
t5	42.3
t6	28.43
t7	48.36
t8	41.36
t9	42.38
t10	38.09
t11	55.59
t12	359.11

Source: Researcher Processed Data

Table 4. Cycle Time of Segmental Pierhead Erection Pack with Beam Lifter on Span 2

Time Code	Cycle Time (Minutes) Span 2
t1	19.46
t2	7.29
t3	30.35
t4	7.53
t5	42.1
t6	26.15
t7	46.23
t8	43.05
t9	42.2
t10	40.06
t11	52.03
t12	356.45

Source: Researcher Processed Data

Table 5. Cycle Time of Segmental Pierhead Erection Pack with Beam Lifter at Span 3

Time Code	Cycle Time (Minutes) Span 3
t1	16.58
t2	6.52
t3	29.44
t4	8.38
t5	40.08
t6	27.16
t7	46.45
t8	43.12
t9	46.38
t10	41.53
t11	51.39
t12	357.03

Source: Researcher Processed Data

Table 6. Cycle Time of Segmental Pierhead Erection Pack with Beam Lifter at Span 4

Time Code	Cycle Time (Minutes) Span 4
t1	18.39
t2	8.57
t3	28.48
t4	7.23
t5	43.45
t6	27.37
t7	47.31
t8	42.55
t9	44.17
t10	39.06
t11	52.11
t12	358.69

Source: Researcher Processed Data

Table 7. Cycle Time of Segmental Pierhead Erection Pack with Beam Lifter at Span 5

Time Code	Cycle Time (Minutes) Span 5
t1	19.32
t2	7.49
t3	28.1
t4	7.4
t5	41.55
t6	28.14
t7	47.21
t8	41.44
t9	47.32
t10	38.58
t11	54.39
t12	360.94

Source: Researcher Processed Data

The next step is to calculate the productivity of the beam lifter as a lifting tool for the span 1-5. Here are the steps for calculating the productivity of the beam lifter:

Total cycle time = Total t12 total (5 segmental pierheads)
= t12 pierhead 1 + t12 pierhead 2 + t12 pierhead 3 + t12 pierhead 4 + t12 pierhead 5
= 359.11 + 356.45 + 357.03 + 358.69 + 360.94 = 1792.22 minutes

Average / pierhead $= \frac{Total\ cycle\ time}{jml\ pierhead}$

$= \frac{1792,22}{5}$

$= 358,444\ menit/pierhead$

Productivity = qx $\frac{60}{rata-rata\ perpierhead}\ x\ efisiensi$

= 1 x $\frac{60}{358,444}\ x\ 0,75$

= 0.125 pierhead / hour

Productivity / hour = 0.125 pierheads / hour

Productivity / day = 0.125 x 8 hours

= 1,004 ≈ 1 pierhead / day

4.2. Time of Segmental Pierhead Erection Work with Crawler Crane

The calculation of the work duration and productivity of segmental pierhead erection with a crawler crane is done by direct observation in the field. The number of pierhads to be observed is 5 or 5 spans.

Table 8. Time Code Cycle of Erection Pierhead Segmental Work with Crawler Crane

Kode Waktu	Keterangan
t1	Pengaturan posisi *crawler crane* untuk *erection segment* 1
t2	*Checklist* kondisi *crawler crane*
t3	Pengangkatan *segment* 1 sampai atas *pier*
t4	Cek elevasi setelah itu install strand looping
t5	Stressing looping tendon
t6	Pengaturan posisi *crawler crane* dan pemasangan tambang pada *segment* 2 (kanan & kiri)
t7	Pengangkatan segment 2 (kanan & kiri)
t8	Install dan stressing strand segment 2 (kanan & kiri)
t9	Pengaturan posisi *crawler crane* dan pemasangan tambang pada *segment* 3 (kanan & kiri)
t10	Pengangkatan segment 3 (kanan & kiri)
t11	Install dan stressing strand segment 3 (kanan & kiri)
t12	t1+t2+t3+t4+t5+t6+t7+t8+t9+t10+t11

The results of recording the cycle time of segmental pierhead erection work using a beam lifter can be seen in the following table:

Table 9. Cycle Time of Segmental Pierhead Erection Cycle with Crawler Crane at Span 1

Time Code	Cycle Time (Minutes) Span 1
t1	17.5
t2	8,12
t3	28.33
t4	7.58
t5	44.46
t6	25.47
t7	32.28
t8	42.13
t9	27.19
t10	34.21
t11	49.09
t12	316.36

Source: Researcher Processed Data

Table 10. Cycle Time of Segmental Pierhead Erection Cycle with Crawler Crane at Span 2

Time Code	Cycle Time (Minutes) Span 2
t1	18.32
t2	7.21
t3	27.28
t4	8.15
t5	43.56
t6	26.37
t7	33.16
t8	41.58
t9	28.47
t10	35.49
t11	52.08
t12	321.67

Source: Researcher Processed Data

Table 11. Cycle Time of Segmental Pierhead Erection Cycle with Crawler Crane at Span 3

Time Code	Cycle Time (Minutes) Span 3
t1	17.42
t2	8.1
t3	28.22
t4	8.17
t5	45.45
t6	27.32
t7	32.12
t8	43.04
t9	27.38
t10	36.31
t11	50.04
t12	323.57

Source: Researcher Processed Data

Table 12. Cycle Time of Segmental Pierhead Erection Cycle with Crawler Crane at Span 4

Time Code	Cycle Time (Minutes) Span 4
t1	16.53
t2	9.02
t3	32.37
t4	7,2
t5	44.42
t6	26.36
t7	32.23
t8	44.1
t9	26.22
t10	34.03
t11	49.59
t12	322.07

Source: Researcher Processed Data

Table 13. Cycle Times of Segmental Pierhead Erection Cycle with Crawler Crane at Span 5

Time Code	Cycle Time (Minutes)
	Span 5
t1	19.09
t2	8.45
t3	28.2
t4	8.58
t5	42.55
t6	27.39
t7	35.08
t8	42.02
t9	27.37
t10	35.31
t11	48.15
t12	322.19

Source: Researcher Processed Data

The next step is to calculate the productivity of the beam lifter as a lifting tool for the span 1-5. Here are the steps for calculating the productivity of the beam lifter:

Total cycle time = Total t12 total (5 segmental pierheads)
= t12 pierhead 1 + t12 pierhead 2 + t12 pierhead 3 + t12 pierhead 4 + t12 pierhead 5
= 316.36 + 321.67 + 323.57 + 322.07 + 322.19 = 1605.86 minutes

Average / pierhead $= \frac{Total\ cycle\ time}{jml\ pierhead}$

$= \frac{1605,86}{5}$

$= 321,172\ menit/pierhead$

Productivity = qx$\frac{60}{rata-rata\ perpierhead} x\ efisiensi$

= 1 x $\frac{60}{321,172} x\ 0,75$

= 0.140 pierhead / hour

Productivity / hour = 0.140 pierheads / hour

Productivity / day = 0.140 x 8 hours

= 1,121≈ 1 pierhead / day

4.3. Cost of Segmental Pierhead Erection Work with Beam Lifter

The breakdown of the cost of segmental pierhead erection with beam lifters is done by calculating the performance index of the tool.

Table 14. Beam Lifter Price Data

Alat Berat	Biaya Sewa	Biaya per Hari
Beam lifter	Rp. 800.000.000/bulan	Rp. 26.667.000

Sumber: Data Internal Proyek

Table 15. Data on Wages of Segmental Erection Pierhead Labor with Beam Lifter

Tenaga Kerja	Upah Per Bulan	Upah Per Hari
Tenaga Ahli (*skilled labour*)		Rp. 115.000
Operator	Rp. 5.500.000	Rp. 180.000
Pengarah (*rigger*)	Rp. 7.500.000	Rp. 250.000
Mandor		Rp. 125.000
Pekerja (*labour*)		Rp. 95.000

Sumber: Data Internal Proyek

The data on labor wages in the table above is the wages of each worker that the authors get from the project's internal data. Most of the payment of labor wages is calculated in one working day, but some are paid per month.

Table 16. Workforce on Beam Lifter

Pekerjaan	Sampel 1					Sampel 2				
	a	b	c	d	e	a	b	c	d	e
Pengaturan Lalu Lintas & Pemasangan Aksesoris				1	6				1	7
Pemasangan *Beam Lifter*		1	2		5		1	2		4
Erection Pierhead Segmental	2	1	2	1	4	1	1	2	1	5
Penyambungan Segmen		1	2	1	7		1	2	1	6
Pelepasan Aksesoris LG dengan Segmen Girder		1	1		3		1	1		2
Total Tenaga Kerja	13					13				

Sumber: Data Olahan Peneliti

3. Information :
4. a= Expert
5. b = operator
6. c = Rigger
7. d = foreman
8. e = Worker

Table 17. Beam Lifter Performance Per Pierhead

Day -1	
Working hours	22.00 - 04.30
Total Working Hours	6 Hours 30 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	1
Steering (riger)	2
Foreman	1
Worker (labor)	7
Number of Tools	1
Day 2	
Working hours	22.15 - 05.00
Total Working Hours	6 Hours 45 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	1
Steering (riger)	2
Foreman	1
Worker (labor)	7
Number of Tools	1
Day 3	
Working hours	22.00 - 05.00
Total Working Hours	7 Hours 00 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	1
Steering (riger)	2
Foreman	1
Worker (labor)	7
Number of Tools	1
Day 4	
Working hours	22.00 - 04.30
Total Working Hours	6 Hours 30 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	1
Steering (riger)	2
Foreman	1
Worker (labor)	7
Number of Tools	1

Day 5	
Working hours	22.00 - 05.00
Total Working Hours	7 Hours 00 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	1
Steering (riger)	2
Foreman	1
Worker (labor)	7
Number of Tools	1

Source: Researcher Processed Data

The next step is to calculate the beam lifter performance index for one pierhead. The calculation of the segmental pierhead erection cost index using a beam lifter is done with the following formula:

$$\text{Index} = \frac{Total\ jam\ kerja}{Jam\ kerja\ normal}\ x\ \frac{Jml\ tenaga\ kerja/jml\ \ alat\ berat}{Jml\ komponen\ yang\ terpasang}$$

Table 18. Beam Lifter Performance Index for 1 Pierhead

Tanggal	Hari ke-1 Indeks	Hari ke-2 Indeks	Hari ke-3 Indeks	Hari ke-4 Indeks	Hari ke-5 Indeks
Total Jam Kerja (8 jam/480 menit)	390 menit	405 menit	420 menit	390 menit	420 menit
Jumlah Segmen Terpasang	1	1	1	1	1
Jumlah Tenaga Kerja					
Tenaga Ahli (*skilled labour*)	1,63	1,69	1,75	1,63	1,75
Operator	1,63	1,69	1,75	1,63	1,75
Pengarah (*riger*)	0,81	0,84	0,88	0,81	0,88
Mandor	0,81	0,84	0,88	0,81	0,88
Pekerja (*labour*)	5,69	5,91	6,13	5,69	6,13
Alat	0,81	0,84	0,88	0,81	0,88

Table 19. Average Beam Lifter Performance Index for One Pierhead

Rata-Rata Indeks	
Tenaga Ahli (*skilled labour*)	1,69
Operator	1,69
Pengarah (*riger*)	0,84
Mandor	0,84
Pekerja (*labour*)	5,91
Alat	0,84

The following is the calculation result of segmental pierhead erection work using beam lifters per one segment:

Table 20. Total Price for the Installation of One Segmental Pierhead with Beam Lifter

Item	Indeks	Satuan	Harga Satuan		Jumlah	
Tenaga Ahli (*skilled labour*)	1,69	OH	Rp	115.000	Rp	194.350
Operator	1,69	OH	Rp	180.000	Rp	304.200
Pengarah (*riger*)	0,84	OH	Rp	250.000	Rp	210.000
Mandor	0,84	OH	Rp	125.000	Rp	105.000
Pekerja (*labour*)	5,91	OH	Rp	95.000	Rp	561.450
Alat (*beam lifter*)	0,84	Hari	Rp	26.667.000	Rp	22.400.280
				Total	**Rp**	**23.775.280,-**

Sumber: Data Olahan Penelitit

the table above, it can be seen that the total price for segmental pierhead erection using a beam lifter per pierhead is IDR 23,775,280.

4.4. Cost of Segmental Pierhead Erection Work with Crawler Crane

Details of the cost of segmental pierhead erection with a crawler crane are done by calculating the performance index of the tool.

Table 21. Crawler Crane Price Data

Alat Berat	Biaya Sewa	Biaya per Hari
Crawler Crane	Rp. 500.000.000/bulan	Rp. 16.760.666

Table 22. Data on Segmental Erection Pierhead Labor Wages with Crawler Crane

Tenaga Kerja	Upah Per Bulan	Upah Per Hari
Tenaga Ahli (*skilled labour*)	Rp. 5.000.000	Rp. 160.000
Operator	Rp. 5.000.000	Rp. 160.000
Pengarah (*rigger*)	Rp. 7.500.000	Rp. 250.000
Mandor		Rp. 125.000
Pekerja (*labour*)		Rp. 95.000

Sumber: Data Internal Proyek

The data on labor wages in the table above is the wages of each worker that the authors get from the project's internal data. Most of the payment of labor wages is calculated in one month of work, but some are paid per day.

Table 23. Workforce on a Crawler Crane

Pekerjaan	Sampel 1					Sampel 2				
	a	b	c	d	e	a	b	c	d	e
Pengaturan Lalu Lintas & Pemasangan Aksesoris				1	8				1	8
Pemasangan CC dengan *segmen pierhead*			1		4			1		4
Erection Pierhead segmental Segmen Girder	2	2	3	2	2	2	2	2	1	2
Penyambungan Segmen Girder dengan *Pier*		2	1	1	6		2	1	1	6
Pelepasan Aksesoris CC dengan Segmen Girder		2			3		2			3
Total Tenaga Kerja			16					16		

Sumber: Data Olahan Peneliti

Information :
a = Expert
b = operator
c = Rigger
d = foreman
e = Worker

Table 24. Performance of Crawler Crane Pierhead

Day -1	
Working hours	22.00 - 04.15
Total Working Hours	6 Hours 15 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	2
Steering (riger)	3
Foreman	1
Worker (labor)	8
Number of Tools	2
Day 2	
Working hours	22.15 - 04.00
Total Working Hours	5 Hours 45 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	2
Steering (riger)	3
Foreman	1
Worker (labor)	8
Number of Tools	2
Day 3	
Working hours	22.00 - 04.30
Total Working Hours	6 Hours 30 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	2
Steering (riger)	3
Foreman	1
Worker (labor)	8
Number of Tools	2
Day 4	
Working hours	22.00 - 04.00
Total Working Hours	6 Hours 00 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	2
Steering (riger)	3
Foreman	1
Worker (labor)	8
Number of Tools	2

Day 5	
Working hours	22.00 - 04.15
Total Working Hours	6 Hours 15 Minutes
Number of Attached Pierheads	1
Skilled Labor	2
Operator	2
Steering (riger)	3
Foreman	1
Worker (labor)	8
Number of Tools	2

Source: Researcher Processed Data

The next step is to calculate the crawler crane performance index for one pierhead. The calculation of the segmental pierhead erection cost index using a crawler crane is carried out with the following formula:

$$\text{Index} = \frac{Total\ jam\ kerja}{Jam\ kerja\ normal}\ x\ \frac{Jml\ tenaga\ kerja/jml\ \ alat\ berat}{Jml\ komponen\ yang\ terpasang}$$

Table 25. CC Performance Index for Pierhead 1

Tanggal	Hari ke-1	Hari ke-2	Hari ke-3	Hari ke-4	Hari ke-5
	Indeks	Indeks	Indeks	Indeks	Indeks
Total Jam Kerja (8 jam/480 menit)	375 menit	345 menit	390 menit	360 menit	375 menit
Jumlah Segmen Terpasang	1	1	1	1	1
Jumlah Tenaga Kerja					
Tenaga Ahli (*skilled labour*)	1,56	1,44	1,63	1,50	1,56
Operator	1,56	1,44	1,63	1,50	1,56
Pengarah (*riger*)	2,34	2,16	2,44	2,25	2,34
Mandor	0,78	0,72	0,81	0,75	0,78
Pekerja (*labour*)	6,25	5,75	6,50	6,00	6,25
Alat	1,56	1,44	1,63	1,50	1,56

Table 26. Crawler Crane Performance Iendex For On Pierhead

Rata-Rata Indeks	
Tenaga Ahli (*skilled labour*)	1,54
Operator	1,54
Pengarah (*riger*)	2,31
Mandor	0,77
Pekerja (*labour*)	6,15
Alat	1,54

Sumber: Data Olahan Peneliti

The following is the calculation result of segmental pierhead erection work using beam lifters per one segment:

Table 27. Total Price for Installing One Segmental Pierhead with a Crawler Crane

Item	Indeks	Satuan	Harga Satuan		Jumlah
Tenaga Ahli (*skilled labour*)	1,54	OH	Rp 160.000	Rp	246.000
Operator	1,54	OH	Rp 160.000	Rp	246.000
Pengarah (*riger*)	2,31	OH	Rp 250.000	Rp	576.563
Mandor	0,77	OH	Rp 125.000	Rp	96.094
Pekerja (*labour*)	6,15	OH	Rp 95.000	Rp	584.250
Alat (*crawler crane*)	1,54	Hari	Rp 16.760.666	Rp	25.769.524
				Total	**Rp. 27.518.430,-**

Sumber: Data Olahan Peneliti

In the table above, it can be seen that the total price for segmental pierhead erection using a crawler crane per one pierhead is Rp. 27,518,430, -

Table 28. Crawler Crane Comparison of Beam Lifter and Prices

Item	Alat Berat			
	Beam lifter		*Crawler Crane*	
Tenaga Ahli (*skilled labour*)	Rp	194.350	Rp	246.000
Operator	Rp	304.200	Rp	246.000
Pengarah (*riger*)	Rp	210.000	Rp	576.563
Mandor	Rp	105.000	Rp	96.094
Pekerja (*labour*)	Rp	561.450	Rp	584.250
Alat (*beam lifter*)	Rp	22.400.280	Rp	25.769.524
Total	**Rp**	**23.775.280**	**Rp**	**27.518.430**
Persentase perbandingan biaya (%)		46,35%		53,65%

Sumber: Data Olahan Peneliti

4.5. Questionnaire Stage 1

The first stage questionnaire is an early stage questionnaire which aims to see expert responses regarding the variables that have been selected by the researcher through literature studies. Experts provide comments and input on variables so that they are more relevant for use at the next stage. The researcher gave a questionnaire to the experts which consisted of 46 variables. Then the expert will respond to the variables that have been determined by the author.

The results of the first stage questionnaire, namely that there is 1 variable that the expert eliminates, namely as follows:

Table 29. Results of the Phase I Questionnaire

Deleted Variables	
Code	Variable
X35	Payment by Owner to Contractor

Source: Researcher Processed Data

4.6. Questionnaire Stage 2

Furthermore, distributing questionnaires that have previously been validated by experts. Questionnaires were distributed to employees of PT. Acset Indonusa, Tbk in the JAPEK Elevated Toll project 2. Respondents were asked to fill in the level of influence of the variables proposed by the researcher on the two methods of segmental pierhead erection work on the JAPEK Elevated 2 Toll project.

4.6.1. Beam Lifter Validity Test

Requirements for the value of the validity test are if the value of R count> R table; 0.301. Of the 45 variables that had been tested for validity through the SPSS v22 software application, it was found that all variables were declared valid. And 1 dependent variable (Y) is also valid.

4.6.2. Beam Lifter Reliability Test

Reliability test is done to see the extent to which the measurement of a test remains consistent after being repeated on the subject and in the same conditions.

Table 30. Reliability Statistics (Beam lifter)

Reliability Statistics	
Cronbach's Alpha	N of Items
.946	46

Source: Researcher Processed Data

4.6.3. Beam Lifter Correlation Coefficient Test

In the correlation coefficient test, the basis for decision making is if the Sig. <0.05, the value is said to be correlated. The results can be seen in the table below:

Table 31. Correlation Testing for X and Y variables (Beam lifter)

No.	Kode	Signifikasi	Pearson Correlation	Syarat Nilai	Keterangan
1	X1	0,087	0,258	0,05	TIDAK KORELASI
2	X2	0,59	0,082	0,05	TIDAK KORELASI
3	X3	0,646	0,07	0,05	TIDAK KORELASI
4	X4	0,185	0,201	0,05	TIDAK KORELASI
5	X5	0,049	0,294	0,05	KORELASI
6	X6	0,654	0,069	0,05	TIDAK KORELASI
7	X7	0,738	0,051	0,05	TIDAK KORELASI
8	X8	0,2	0,195	0,05	TIDAK KORELASI
9	X9	0,66	0,067	0,05	TIDAK KORELASI
10	X10	0,085	0,26	0,05	TIDAK KORELASI
11	X11	0,939	0,012	0,05	TIDAK KORELASI
12	X12	0,027	0,33	0,05	KORELASI
13	X13	0,997	0	0,05	TIDAK KORELASI
14	X14	0,002	0,448	0,05	KORELASI
15	X15	0,005	0,413	0,05	KORELASI
16	X16	0,023	0,338	0,05	KORELASI
17	X17	0,052	0,291	0,05	TIDAK KORELASI
18	X18	0,003	0,428	0,05	KORELASI
19	X19	0,008	0,39	0,05	KORELASI
20	X20	0,26	0,171	0,05	TIDAK KORELASI
21	X21	0,26	0,171	0,05	TIDAK KORELASI
22	X22	0,156	0,215	0,05	TIDAK KORELASI
23	X23	0,294	0,16	0,05	TIDAK KORELASI
24	X24	0,107	0,244	0,05	TIDAK KORELASI
25	X25	0,378	0,134	0,05	TIDAK KORELASI
26	X26	0,467	0,111	0,05	TIDAK KORELASI
27	X27	0,017	0,353	0,05	KORELASI
28	X28	0,039	0,309	0,05	KORELASI
29	X29	0,154	0,216	0,05	TIDAK KORELASI
30	X30	0,155	0,216	0,05	TIDAK KORELASI
31	X31	0,057	0,286	0,05	TIDAK KORELASI
32	X32	0,001	0,467	0,05	KORELASI
33	X33	0,042	0,305	0,05	KORELASI
34	X34	0,006	0,401	0,05	KORELASI
35	X35	0,027	0,33	0,05	KORELASI
36	X36	0,003	0,432	0,05	KORELASI
37	X37	0	0,509	0,05	KORELASI
38	X38	0,086	0,259	0,05	TIDAK KORELASI
39	X39	0,083	0,261	0,05	TIDAK KORELASI
40	X40	0,003	0,437	0,05	KORELASI
41	X41	0,092	0,254	0,05	TIDAK KORELASI
42	X42	0,55	0,091	0,05	TIDAK KORELASI
43	X43	0,208	0,191	0,05	TIDAK KORELASI
44	X44	0	0,673	0,05	KORELASI
45	X45	0,73	-0,053	0,05	TIDAK KORELASI

The table above shows that there are 17 independent variables (X) that are correlated with the dependent variable (Y).

4.6.4. Beam Lifter Regression Test

Regression test to determine the relationship between the independent variable and the dependent variable.

Table 32. Regression Test Table (Beam Lifter)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.470	.553		.848	.401
	X_44	.868	.145	.673	5.971	.000
2	(Constant)	-.584	.640		-.913	.367
	X_44	.796	.138	.617	5.777	.000
	X_15	.320	.116	.296	2.770	.008

a. Dependent Variable: Y_1

Sumber: Data Olahan Peneliti

Regression equation:

Y '= a + b1X1 + b2X2 + b3X3 + ……. + bnXn Y '= 0.584 + 0.796X44 + 0.320X15

a. The constant is -0.584; means that if X1, X2, Xn are fixed values, then (Y) the value is -0.584 units.
b. The regression coefficient for the variable X44 is 0.796 or 79.6%; This means that if other independent variables are fixed in value and X44 increases by 1 unit, then the Y value will increase by 0.796 units or 79.6%. The coefficient is positive, meaning that there is a positive relationship between X44 and the value of Y, the higher the value of X44, the higher the value of Y. Paying attention to the provision / procurement of utilities in segmental pierhead erection work with beam lifters greatly affects the effectiveness of using the beam lifter itself.
c. The regression coefficient for the variable X15 is 0.320 or 32% and the sig value is 0.008> 0.005; meaning that the variable X15 is deleted because the significance value is greater than the requirement, namely 0.005.

4.6.5. R (R^2) Beam Lifter Determination Test

The coefficient of determination is used to determine the percentage of the influence of the independent variables together on the dependent variable by looking at the total coefficient of determination (R2).

Table 33. Table R2 (Beam Lifter)

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.673[a]	.453	.441	.724	
2	.733[b]	.538	.516	.674	2.044

a. Predictors: (Constant), X_44
b. Predictors: (Constant), X_44, X_15
c. Dependent Variable: Y_1

Sumber: Data Olahan Peneliti

The results of the analysis show that the value of R2 is 0.538 where the percentage of the influence of the independent variables, namely heavy equipment mobilization (X44), and load calculation (X15), on the dependent variable (Y2) is 53.8%. While the remaining 46.2% is influenced by other variables which are not included in this research model.

4.6.6. Crawler Crane Validity Test

Requirements for the value of the validity test are if the value of R count> R table; 0.301.

Of the 45 variables that had been tested for validity through the SPSS v22 software application, it was found that all variables were declared valid. And 1 dependent variable (Y) is also valid.

4.6.7. Crawler Crane Reliability Test

Reliability test is done to see the extent to which the measurement of a test remains consistent after being repeated on the subject and in the same conditions.

Table 34. Reliability Statistics (Crawler Crane)

Reliability Statistics

Cronbach's Alpha	N of Items
.950	46

Source: Researcher Processed Data

4.6.8. Crawler Crane Correlation Coefficient Test

In the correlation coefficient test, the basis for decision making is if the Sig. <0.05, the value is said to be correlated. The results can be seen in the table below:

Table 35. Testing the Correlation of X and Y variables (Crawler Crane)

No.	Kode	Signifikasi	Pearson Correlation	Syarat Nilai	Keterangan
1	X1	0,014	0,362	0,05	KORELASI
2	X2	0,064	0,279	0,05	TIDAK KORELASI
3	X3	0,005	0,413	0,05	KORELASI
4	X4	0,368	0,137	0,05	TIDAK KORELASI
5	X5	0,139	0,224	0,05	TIDAK KORELASI
6	X6	0,024	0,336	0,05	KORELASI
7	X7	0,039	0,309	0,05	KORELASI
8	X8	0,003	0,438	0,05	KORELASI
9	X9	0,020	0,345	0,05	KORELASI
10	X10	0,021	0,344	0,05	KORELASI
11	X11	0,275	0,166	0,05	TIDAK KORELASI
12	X12	0,007	0,397	0,05	KORELASI
13	X13	0,100	0,248	0,05	TIDAK KORELASI
14	X14	0,018	0,35	0,05	KORELASI
15	X15	0,038	0,31	0,05	KORELASI
16	X16	0,001	0,491	0,05	KORELASI
17	X17	0,005	0,416	0,05	TIDAK KORELASI
18	X18	0,000	0,498	0,05	KORELASI
19	X19	0,061	0,282	0,05	TIDAK KORELASI
20	X20	0,051	0,294	0,05	TIDAK KORELASI
21	X21	0,051	0,296	0,05	TIDAK KORELASI
22	X22	0,070	0,272	0,05	TIDAK KORELASI
23	X23	0,071	0,272	0,05	TIDAK KORELASI
24	X24	0,000	0,607	0,05	TIDAK KORELASI
25	X25	0,003	0,437	0,05	KORELASI
26	X26	0,184	0,202	0,05	TIDAK KORELASI
27	X27	0,132	0,228	0,05	TIDAK KORELASI
28	X28	0,016	0,358	0,05	KORELASI
29	X29	0,017	0,353	0,05	KORELASI
30	X30	0,005	0,409	0,05	KORELASI
31	X31	0,000	0,551	0,05	KORELASI
32	X32	0,008	0,392	0,05	KORELASI
33	X33	0,111	0,241	0,05	TIDAK KORELASI
34	X34	0,156	0,215	0,05	TIDAK KORELASI
35	X35	0,673	0,065	0,05	TIDAK KORELASI
36	X36	0,015	0,361	0,05	KORELASI
37	X37	0,125	0,232	0,05	TIDAK KORELASI
38	X38	0,013	0,366	0,05	KORELASI
39	X39	0,044	0,302	0,05	KORELASI
40	X40	0,024	0,337	0,05	KORELASI
41	X41	0,008	0,393	0,05	KORELASI
42	X42	0,763	0,046	0,05	TIDAK KORELASI
43	X43	0,001	0,461	0,05	KORELASI
44	X44	0,000	0,517	0,05	KORELASI
45	X45	0,000	0,513	0,05	KORELASI

Source: Researcher Processed Data

The table above shows that there are 26 independent variables (X) that are correlated with the dependent variable (Y).

4.6.9. Crawler Crane Regression Test

Regression test to determine the relationship between the independent variable and the dependent variable.

Table 36. Regression Test Table (Crawler Crane)

Coefficients*						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.106	.505		4.173	.000
	X_31	.488	.113	.551	4.331	.000
2	(Constant)	.357	.667		.536	.595
	X_31	.407	.103	.459	3.963	.000
	X_45	.469	.132	.411	3.542	.001
3	(Constant)	-.170	.641		-.266	.792
	X_31	.330	.098	.372	3.357	.002
	X_45	.408	.124	.357	3.295	.002
	X_44	.303	.104	.323	2.907	.006

a. Dependent Variable: Y_2

Sumber: Data Olahan Peneliti

Regression equation:

Y '= a + b1X1 + b2X2 + b3X3 + ……. + bnXn

Y '= 0.170 + 0.330X31 + 0.408X45 + 0.303X44

a. The constant is -0.170; meaning that if X1, X2, X3, Xn the value is fixed, then (Y) the value is -0,170 units.
b. The regression coefficient for the X31 variable is 0.330 or 33%; This means that if other independent variables are fixed in value and X31 increases by 1 unit, then the Y value will increase by 0.330 units or 33%. The coefficient is positive, meaning that there is a positive relationship between X31 and the Y

value, the higher the X31 value, the higher the Y value. Paying attention to stressing PH conditions in segmental pierhead erection work with the crawler crane greatly affects the effectiveness of using the crawler crane itself.

c. The regression coefficient for the variable X45 is 0.408 or 40.8%; This means that if other independent variables are fixed in value and X45 increases by 1 unit, then the Y value will increase by 0.408 units or 40.8%. The coefficient is positive, meaning that there is a positive relationship between X45 and the Y value, the higher the X45 value, the higher the Y value.This means that by paying attention to the condition of the ground in erection work with the crawler crane, it will further affect the effectiveness of using the crawler crane in segmental pierhead erection work.

d. The regression coefficient for the variable X44 is 0.303 or 30.3% and the sig value is 0.006> 0.005; meaning that the variable X44 is deleted because the significance value is greater than the requirement, namely 0.005.

4.6.10. Crawler Crane R (R^2) Determination Test

The coefficient of determination is used to determine the percentage of the influence of the independent variables together on the dependent variable by looking at the total coefficient of determination (R2).

Table 37. Table R2 (Crawler Crane)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.551a	.304	.287	.701
2	.681b	.464	.438	.622
3	.745c	.555	.523	.573

a. Predictors: (Constant), X_31

b. Predictors: (Constant), X_31, X_45

c. Predictors: (Constant), X_31, X_45, X_44

Source: Researcher Processed Data

The results of the analysis show that the value of R2 is 0.555 where the percentage of the influence of the independent variables, namely heavy equipment mobilization (X11), and load calculation (X50), on the dependent variable (Y2) is 55.5%. While the remaining 44.5% is influenced by other variables which are not included in this research model.

4.6.11. Expert Validation

The next stage, the variables are conveyed back for final validation to the same expert in stage I. Final (expert) validation is carried out by submitting a final (expert) questionnaire to the experts to find out the expert's opinion whether they agree or not and to provide an opinion on the variables that affect the effectiveness of the beam lifter. and crawler cranes in segmental pierhead erection work in order to find out what method is most effective to use in the Jakarta - Cikampek Elevated Toll project 2.

Table 38. Table of Expert Validation Recap (Beam lifter)

Variabel	Pakar 1		Pakar 2		Pakar 3		Kesimpulan
	Setuju	Tidak Setuju	Setuju	Tidak Setuju	Setuju	Tidak Setuju	
Kesediaan Peralatan dan Material (X15)	✔		✔		✔		

Sumber: Data Olahan Peneliti

The results of the final expert validation are as follows:

Table 39. Expert Validation Recap Table (Crawler Crane)

Variabel	Pakar 1		Pakar 2		Pakar 3		Kesimpulan
	Setuju	Tidak Setuju	Setuju	Tidak Setuju	Setuju	Tidak Setuju	
Kondisi *Stressing* PH (X31)	✔		✔		✔		
Keadaan Tanah (X45)	✔		✔		✔		

Sumber: Data Olahan Peneliti

5. Conclusion

a. From the aspect of time, the results of the calculation of cycle time and productivity in the segmental pierhead erection work are as follows:

Table 40. Comparison of Segmental Pierhead Erection Cycle Times

Alat	Rata-rata Waktu Siklus (menit)	Jumlah *Pierhead* (per hari)
Beam Lifter	358,444 menit	3 segmental PH/ 1 pierhead
Crawler Crane	321,172 menit	3 segmental PH/ 1 pierhead

Sumber: Data Olahan Peneliti

The difference in time is due to the erection of the segmental pierhead using a beam lifter for too long when moving the tool from 1 pier to the next so that in the preparation stage of segmental pierhead erection work using a beam lifter it takes a long time to move the lifting equipment.

b. From the aspect of cost, the calculation of the performance index of the tool can be concluded as follows:

Table 41. Comparison of Segmental Pierhead Erection Costs

Alat	Harga (per 1 *pierhead*)
Beam Lifter	Rp. 23.775.280,-
Crawler Crane	Rp. 27.518.430,-

Sumber: Data Olahan Peneliti

It can be seen in the table above that segmental pierhead erection work using beam lifters is cheaper than the cost of segmental pierhead erection using a crawler crane.

c. The results showed that the variable that affected the effectiveness of segmental pierhead erection using Beam Lifter was the availability of equipment and material (X15) where the percentage of influence of these variables with the dependent variable (Y) was 53.8%.

d. Meanwhile, the research results show that the variables that affect the effectiveness of segmental pierhead erection using a crawler crane are stressing conditions PH (X31) and soil conditions (X45) where the percentage of influence of these variables with the dependent variable (Y) is 55.5%. So it can be seen that segmental pierhead erection using a crawler crane is more effective than using a beam lifter. Where the percentage of influence (crawler crane) on variable Y is 55.5%.

6. Suggestion

In the Toll Jakarta - Cikampek Elevated 2 project, segmental pierhead erection with beam lifters and crawler cranes can be used both, but the use of the crawler crane method is better used because it is considered to be faster efficient and can speed up the schedule even though the crawler crane method is more expensive than the beam. lifter however the difference is only slight.

The erection method was chosen for the next project which is almost the same as the Jakarta - Cikampek Elevated 2 Toll project so that it is better to examine all the factors that are likely to occur during the project, so that work methods do not change in the middle of the work (Cabinet Secretariat Of The Republic Of Indonesia, 2019).

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