

The Design of The Drainage Channel for District V Penfui Timur Village

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Abstract

The planning of drainage channels for the people of District V of Penfui Timur Village is considered important to support built facilities such as roads and housing areas so that they are free from inundation when there is high intensity of rainfall. Therefore, through the International Thematic KKN activities by the Faculty of Engineering, Widya Mandira Catholic University, and the Dili Institute of Technology, students and lecturers collaborated to design drainage channels for asphalt roads and dirt roads in District V, Penfui Timur Village. The results of the analysis show that asphalt roads with a return period of 2 years require a channel width (B) of 40 cm and a depth (y) of 20 cm, while a return period of 5 years requires a channel width (B) of 46 cm and for a depth (y) channel of 25 cm. On the other hand, a dirt road with a return period of 2 years requires a channel width (b) of 41 cm and a channel depth (y) of 21 cm, while a return period of 5 years requires a channel width (b) of 46 cm and for a channel depth (y) of 23cm.

Keywords: DIT, drainage, Penfui Timur, UNWIRA

INTRODUCTION

Penfui Timur Village is a developing village located in Kupang Regency, East Nusa Tenggara. It has 5 districts with a population of 10,440 people and an annual population growth rate of 5.18% (Kecamatan Dalam Angka Kupang Tengah, 2022). Since it was a developing village, the construction of facilities to support community activities is also highly developed, such as the construction of main access roads and other supporting roads. However, the construction of road facilities has not been accompanied by the construction of drainage channels so when the rain comes, several areas experience puddles.

Through the International Thematic KKN conducted by the Faculty of Engineering, Universitas Katolik Widya Mandira, and the Dili Institute of Technology, the students and lecturers collaborated to design drainage channels for the people of District V of Penfui Timur Village to support community facilities such as roads and housing areas to be free from inundation due to rainfall with high intensity. The location of District V can be seen in Figure 1. The condition of the roads in District V of Penfui Timur Village can be seen in Figure 2. It can be seen that the asphalt roads are still in good condition but do not yet have drainage channels, so when it rains with high intensity the side areas on the left and right of the road are inundated with rainwater runoff.



Figure 1. District V of Penfui Timur Village



Figure 2. Roads Condition in District V of Penfui Timur Village

METHOD

Hydrological Analysis

A hydrological analysis is needed in planning drainage because it relates to rainfall as a source of water that will flow in a drainage system (Wesli, 2008). In the process of carrying out the hydrological analysis, there are several planning criteria including the estimated design rainfall, and analysis of the frequency of rainfall using methods that refer to the procedure for calculating the design discharge of the channel.

The rainfall that occurs in the Penfui Timur area will be a benchmark for calculating the design flood discharge. The rainfall data used is the maximum daily rainfall data collected from El Tari Meteorological Station with the data period from 1990 to 2015. Frequency analysis was carried out to determine the magnitude of extreme events related to their frequency of occurrence through the application of a probability distribution. To determine the suitability of the frequency distribution of the sample data to the probability distribution function, it is necessary to test the parameters using the Chi-Square and Smirnov-Kolmogorov tests.

Hydraulics Analysis

In hydraulics analysis, it uses an open channel flow system. The return period discharge that has been obtained through hydrological analysis will then be used as a basis for hydraulic analysis to calculate the dimensions of the drainage channel to be used in District V of Penfui Timur Village.

The user data is secondary data, they are rainfall data obtained from El Tari Meteorological Station, and area data and land use were analyzed with Google Earth Pro software.

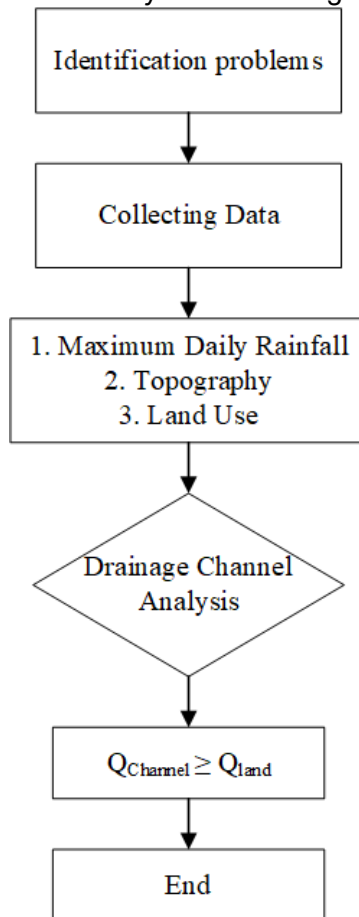


Figure 3. Method

RESULTS AND DISCUSSION

The maximum daily rainfall data of El Tari Meteorological Station for 26 years can be seen in Table 1. Furthermore, from the rainfall data, frequency analysis was carried out with the help of Visual Basic software in Excel to calculate the planned daily rainfall to be used in the analysis. From the results of the analysis, it was found that the distribution corresponding to the rainfall of El Tari Meteorological Station is a Log Normal distribution with design rainfall values can be seen in Table 2.

Table 1. Maximum Daily Rainfall Data of El Tari Meteorological Station

Years	Maximum Daily Rainfall	Years	Maximum Daily Rainfall
1990	84	2003	195
1991	303	2004	133
1992	140	2005	125
1993	96	2006	210
1994	177	2007	130
1995	115	2008	145
1996	184	2009	182
1997	108	2010	100
1998	198	2011	302
1999	190	2012	84

Years	Maximum Daily Rainfall	Years	Maximum Daily Rainfall
2000	164	2013	193
2001	160	2014	96.9
2002	115	2015	127

Table 2. Characteristics of Rainfall According to Probability

Probability	Return Period	Log Normal Distribution (mm)	
		X _T	KT
0.5	2	146.90	-0.16
0.2	5	197.13	0.71

District V of Penfui Timur Village has a 4.1 km² area and is still dominated by forest and wilderness. With an area of forest area reaching 2.49 km². The rests are separate housing areas and combined housing, rice fields, and highway facilities (asphalt and soil). Based on the results of an analysis of the coefficient runoff in District V of Penfui Timur Village, a value of 0.333 was found. Based on these results this value is still good enough to be able to absorb rainwater so that large drainage channels are not needed.

After calculating the value of coefficient runoff, then do trial and error to get the depth of flow value for the design of the drainage channel. Trial and error are carried out using a numerical equation that has been derived to obtain a flow depth value. Table 3 shows the trial and error values for the asphalt channel dimensions with a 2-year rainfall return period.

From Table 3 it can be seen that the speed value obtained after conducting a trial error is 0.903 m²/s. Based on these results, a dimensional analysis was then carried out to obtain the flow height (y) and flow width (b) which would be the benchmark for the dimensional design of the drainage channel in District V of Penfui Timur Village using a 2-year designs rainfall. It was found that for a 2-year return period, the design of the asphalt road drainage channel for District V of Penfui Timur Village required channel dimensions with a depth (y) of 20 cm and width (b) of 40 cm. Furthermore, the same thing was done for the design of the channel with a 5-year return period on asphalt roads and resulting in a depth (y) of 25 cm and a width (b) of 46 cm.

Table 3. Trial Error Value of Drainage Channel Depth

Input Data			
Input			
R ₂₄	= 146.90 mm	t ₀	= 0.02191 hour
L _{lahan}	= 5 m	t _d	= 0.89223 hour
S _{lahan}	= 0.0055	t _c	= 0.91414 hour
L _{saluran}	= 2900 m	Q _{saluran}	= 0.07108 m ³ /s
S _{saluran}	= 0.003	Q _{lahan}	= 0.07108 m ³ /s
C	= 0.333	Q _{saluran} -Q _{lahan}	= 0.00000
n	= 0.013 cement	y	= 0.19840 m
A	= 1.42 ha	B	= 0.39679 m
I	= 54.068 mm/hour		
V	= 0.903 (Solver)		

In addition to analysis for asphalt roads, a channel design analysis was also carried out for dirt roads with a return period of 2 years and 5 years in District V of Penfui Timur Village. The results of the analysis show that the drainage dimensions of a dirt road for a 2-year return

period require a depth (y) of 21 cm and a width (b) of 41 cm, while for a 5-year return period, it requires a depth (y) of 23 cm and a width (b) of 46 cm. The drainage channel design is shown in Figure 4.

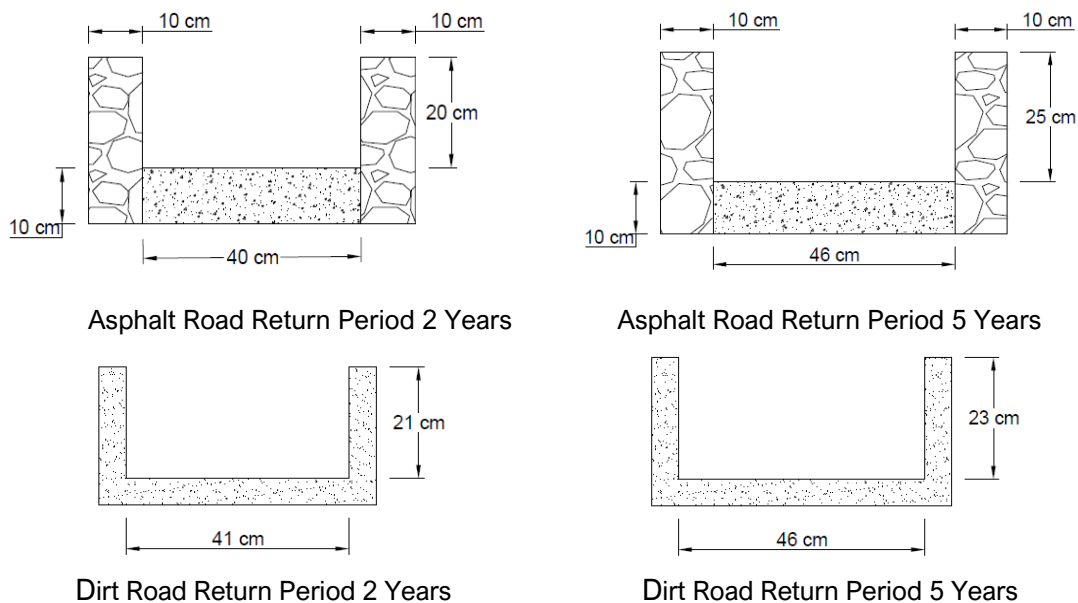


Figure 4. Dimensions of The Drainage Channel

CONCLUSION AND RECOMMENDATION

Conclusion

- District V of Penfui Timur Village still has good quality infiltration so it does not require large dimensions of drainage channels, this can be seen from the relatively small coefficient runoff (C), which is 0.333.
- The depth (y) of the design of the drainage channel in District V of Penfui Timur Village on dirt roads and asphalt roads is not more than 30 cm and the width (b) of the design of the canal is not more than 50 cm.

Recommendation

Suggestions for future drainage channel design analysis might be carried out in more detail to reach the housing area in District V of Penfui Timur Village.

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