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Research Paper

Study of Drainage Channels on National Roads in the Outside of the City

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ABSTRACT: *The puddle on Jember – Surabaya national road, especially in Pecoro Village, Rambi Puji District, Jember Regency, is very close, because the road that occurs is quite high, so it is very disturbing the traffic activities at that location. The main problem of flooding in the area is caused by the inability of the road channel to accommodate the flood water discharge that occurs in the road area. From this problem, it is necessary to study drainage channels on the national road on the outskirts of the city with a case study on the Jember - Surabaya National Road in Pecoro Village, Rambi Puji District, Jember Regency. From the results of this study, it can be said that the planned flood discharge that occurred in the Jember - Surabaya National Road area in Pecoro Village, Rambi Puji District, Jember Regency, for a 10 year return period was 0.757* m^3*/sec. For re-planning the dimensions of the channel are as follows: the depth of the channel (H) = 70 cm and the bottom width (B) = 90 cm, the guard height is 30 cm, and the foundation thickness is 30 cm. It is recommended that road waterways are often maintained so that they function properly so that they can minimize the volume of air discharge entering the highway*

KEYWORDS: *Puddles, Drainage Channel, Road.*

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I. INTRODUCTION

The puddle on the Jember – Surabaya national road, especially in Pecoro Village, Rambi Puji District, Jember Regency is very worrying, because the inundation that occurs is quite high, so it is very disturbing the traffic activities at that location. In addition to being a cause of disruption to the smooth flow of vehicular traffic, the puddle can also cause road damage that has the potential to form holes or hollows that make the road uneven so that it is prone to accidents [1]. The puddle is caused by a drainage channel that is not functioning properly, where the drainage channel is a means to collect water, especially rainwater so that the rainwater does not collect or concentrate on the road. [2].

In general, the cause of a flood is a large design discharge, the main factor being the occurrence of rain that exceeds normal. To determine the planned flood, if in the area the discharge data is very limited then rain data can be used [3]. The amount of flood discharge is strongly influenced by the intensity of the rain. Rain intensity is the high rainfall during the period of concentrated water [4] Analysis of intensity, duration and frequency required data series obtained from rain data. If the rain intensity observation tool is not available, then the empirical method can be used using experimental formulas [5]

The drainage system is strongly influenced by changes in land use. Land use that is very influential is the change in land use which was previously a water catchment area then became residential or housing. [6]. The puddles on the Jember-Surabaya national road, especially in Pecoro Village, Rambi Puji District, Jember Regency, most of the right and left are rice fields. So that the potential for flooding on national roads around the water rice fields needs to be managed properly so that drainage channels need to be adequate [7]. The Poor drainage system can be caused by reduced channel capacity due to the presence of garbage. Stagnant water that occurs on the road is caused by damage to the channel and the presence of garbage in the drainage channel so that it hinders the flow of water. [8].

The main problem of flood inundation in the puddle area on the Jember - Surabaya national road, especially in Pecoro Village, Rambi Puji District, Jember Regency, is caused by the inability of the road channel that functions to accommodate flood water discharge that occurs in the road area. Starting from this problem, it is necessary to study the drainage channel on the national road on the outskirts of the city with a case study on the Jember - Surabaya National Road in Pecoro Village, Rambi Puji District, Jember Regency.

II. METHODOLOGY

The Research Location

This research is located on National Road Jember – Surabaya in Pecoro Village, Rambi Puji District, Jember Regency, East Java.

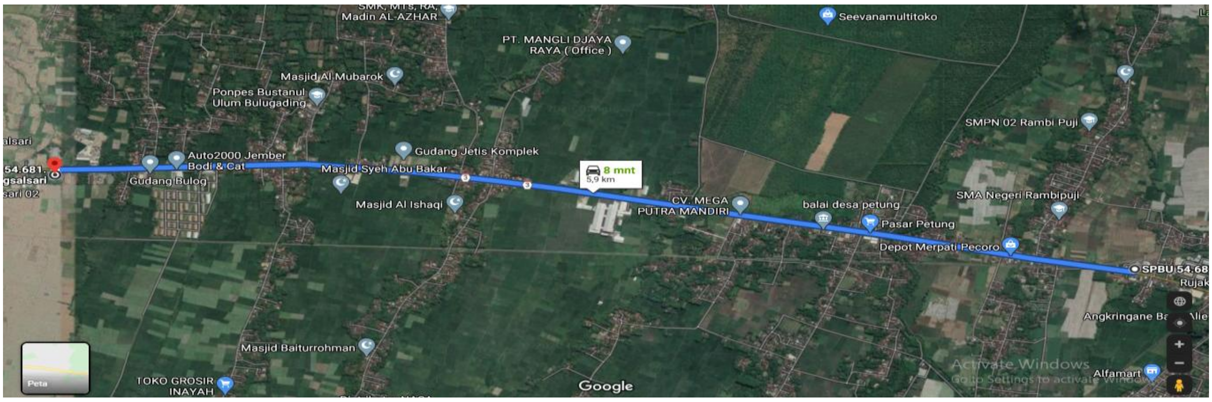


Figure 1 : Research Location

Data Collection Technique

This evaluation uses two types of data, namely primary and secondary data. The type of primary data in this evaluation is obtained from the results of direct measurements and observations, with the aim of obtaining the existing state of the existing drainage channels. Primary data obtained include the condition of the existing canal in the area of the Jember - Surabaya National Road in Pecoro Village, Rambi Puji District, Jember Regency, in the form of shape, width, depth, and slope of the canal wall. The secondary data used in this evaluation are as follows:

a. Rainfall data
   Rainfall data used is rainfall data for the last 10 years, from 2010 to 2019. Rainfall data is obtained from the Rain Station
b. Land use maps
   Land use maps are needed to determine the value of the coefficient of drainage at the research site. Land use is obtained from the appearance seen on Google Earth.
c. Study area map
   The map of the study area is used to determine the condition of the research location. Map obtained from Google Earth.

Hydrological Analysis

The steps of hydrological analysis are as follows

a. Calculate the maximum regional average rainfall
   The maximum regional average rainfall is calculated using the algebraic method or If the rainfall station points are evenly distributed then the algebraic method is used, but if the rainfall station points are not evenly distributed, the Thiessen polygon method is used.
b. Testing data outliers
   The rainfall data outlier test is used to detect whether the maximum and minimum data from the existing data series are suitable for use or not [9].
c. Test consistency
   From the rainfall data obtained, consistency is first tested in determining whether the data deviation occurs or not [10]. If there is a deviation, the rainfall data needs to be multiplied by the correct number before calculating the maximum rainfall. The consistency test used in this study is the rainfall consistency test using the RAPS (Rescale Adjusted Partial Sums) method.
d. Analyze the frequency of rainfall
   Assessing the frequency of rainfall with the Log Pearson III distribution method. And the steps of using the Pearson III Log distribution [11].
e. Distribution test
   There are two kinds of tests, namely the Chi-Square Test and Smirnov-Kolmogorov Test. The Chi-Square test compares X_2 with critical X_2, if $X_2 < X_2$ is critical then the data distribution is appropriate, otherwise another data distribution must be used. The Smirnov – Kolmogorov test compares max with critical, if max is smaller than critical then the data distribution is appropriate, otherwise another data distribution must be used [12].

f. Calculating design debit debit

The method used to calculate the design discharge is the rational method. The mathematical equation of the rational method is expressed in the following form:

Q = Rainwater discharge (m^3/s)
C = Flow Coefficient
I = Rainfall intensity (m/s)
A = Drainage area (m^2)

The flow coefficient value (C) is determined. The flow coefficient of each land use by calculating the weight of each part according to the area it represents. The value of rain intensity (I) is influenced by the duration of rainfall. To be able to determine the intensity of rain, the Mononobe formula is used. Mononobe's formula is as follows

$$I = \frac{R_{24}}{t_{24}}$$

I = rain intensity (mm/hour)
t = time or duration of rain (hours)
R_{24} = maximum rainfall in a day (mm)

The determination of the service area (A) is carried out by looking at the appearance of the earth's surface or topography and also the existing drainage channels.

Dimensional Design Review

The dimension design review is carried out by calculating and designing how many dimensions are suitable for the existing drainage channel in the Jember - Surabaya National Road section in Pecoro Village, Rambi Puji District, Jember Regency so that it is able to accommodate design rain for the next 10 to 25 years. The dimensions of the channel are the width, depth, slope of the channel if the channel is trapezoidal and the height of the guard. Planning the dimensions of the drainage channel is adjusted to the amount of 25 years of design rain, the slope or slope of the channel, the wet circumference of the channel, the hydraulic radius of the channel, the channel surface area, and the channel flow velocity.

Evaluation of Drainage Channel Dimensions

For the dimensions of the channel, it is necessary to know the capacity of the existing channel. The formula used to determine the discharge capacity of the channel is as follows:

Q = V x A
Q = Channel capacity (m^3/s)
A = Cross-sectional area (m^2)

After knowing the capacity of the existing channel, it is compared with the capacity of the design channel. If the design capacity is greater than the capacity of the existing channel, it is necessary to change the dimensions of the channel, but if the discharge capacity of the existing channel is still greater than the design capacity, the channel does not need to be repaired or changed the dimensions of the channel because it is still able to accommodate runoff discharge.

III. RESULTS AND DISCUSSION

Rainfall data

Hydrological analysis of drainage system planning in the Pecoro Village area, rain data used are Pecoro, Langkap and Kijingan stations available for 10 years. In the drainage system, the design rainfall is planned with a return period of 10 years (R10) and flood discharge with a return period of 10 years (Q_{10}). These are presented in table 1.

TAB.1 10 Years of rainfall data Data

No	Station Name	Year (in mm)									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Pecoro	59	56	46	48	41	45	52	43	47	37
2	Langkap	38	55	41	46	34	27	46	30	42	35
3	Kijingan	59	50	45	41	29	35	46	39	42	42

Source: PU and SDA data, 2020

Analysis of Average Maximum Daily Rainfall.
By using the Thiessen polygon, the maximum daily rainfall at the Pecoro, Langkap and Kijingan rain stations is obtained by using the Thiessen polygon method, to determine the drainage area at each station used as follows:
Rain data in 2010:
R_1(Pecoro rain station) = 59 mm,
R_2(Langkap rain station) = 38 mm ,
R_3(Kijingan rain station) = 59 mm ,

$$CH_{2010} = \frac{R_1 + R_2 + R_3}{n}$$
$$= \frac{59 + 38 + 59}{3}$$
$$= 52$$

TAB.2 Maximum Daily Rainfall Calculation Results By using algebraic or arithmetic methods

No.	Year	Annual Maximum Daily Rain (mm)
1	2010	52
2	2011	53,66
3	2012	44
4	2013	45
5	2014	34,66
6	2015	35,66
7	2016	48
8	2017	37,33
9	2018	43,66
10	2019	38

Source: Calculations

Frequency Analysis and Distribution of Design Rain Data
To determine the distribution, namely by means of frequency analysis by looking for the value of the coefficient of slope (Cs), for the steps are as follows:

TAB.3 Frequency Analysis Calculation

No	Tahun	Ri (mm)	P%	$(R_i – R_{rerata})$	$(R_i – R_{rerata})^2$	$(R_i – R_{rereta})^3$	$(R_i – R_{rerata})^4$
1	2010	52	9,09	8,80	77,44	681,472	5.996,95
2	2011	53,666	18,18	10,466	109,54	1146,415875	11.998,389
3	2012	44	27,27	0,80	0,64	0,512	0,41
4	2013	45	36,36	1,8	3,24	5,832	10,4976
5	2014	34,666	45,45	-8,534	72,83	-621,5240173	5304,085964
6	2015	35,666	54,55	-7,534	56,76	-427,6385493	3221,82883
7	2016	48	63,64	4,8	23,04	110,592	530,8416
8	2017	37,333	72,73	-5,867	34,42	-201,9520494	1184,852674
9	2018	43,666	81,82	0,466	0,22	0,101194696	0,047156728
10	2019	38	90,91	-5,2	27,04	-140,608	731,1616
Rata-rata			Jumlah		405,17	553,2024534	28.979,07
SD		1,8066					
Cs		3,0301					
Ck		8,653					

Source: Calculations

Based on the provisions of the coefficient of slope cs = 3.0301 and Ck = 8.653 then the Log person Type III distribution is used in accordance with the distribution selection requirements, the value of the coefficient of slope cs must meet the following criteria:
1. Normal Distribution ; Cs:0, Ck:3
2. Log Normal Distribution ; Cs:3 Cv, Cv:0,6
3. Gumbel distribution ; Cs < 1.1396, Ck < 5,4002
4. Pearson Type III Log Distribution; or not included above

Distribution Distribution Log Person III. The following are the steps for calculating the Distribution of Log Person III and as an example of the calculation using the maximum daily rain in 2010 as follows:
Step 1: The average maximum daily rainfall data in 2010 is 52 mm.
Step 2 = log X
= log 52
= 1.71600
Step 3 = (logX-logX)
= (1.71600 – 1.6348)

= 0.1252
Step4 = (logX-log X)2
= (1.71600 - 1.6348)2
= 0.01567
Step5 = (logX-logX)3
= (1.7600 – 1.6348)3
= 0.001963

TAB.4 Distribution of Log Person III

Year	Ri	Log x	(Logx-X)	$(Logx-X)^2$	$(Logx-X)^3$
2010	52	1,76	0,1252	0,01567504	0,001963
2011	53,666	1,729	0,0942	0,00887364	0,000836
2012	44	1,643	0,0082	6,724E-05	5,51E-07
2013	45	1,653	0,0182	0,00033124	6,03E-06
2014	34,666	1,539	-0,0958	0,00917764	-0,00088
2015	35,666	1,552	-0,0828	0,00685584	-0,00057
2016	48	1,681	0,0462	0,00213444	9,86E-05
2017	37,333	1,572	-0,0628	0,00394384	-0,00025
2018	43,666	1,64	0,0052	2,704E-05	1,41E-07
2019	38	1,579	-0,0558	0,00311364	-0,00017
Total		16,348	1,9984E-15	0,0501996	0,001035
Average (X)		**1,6348**	1,9984E-16	0,00501996	0,000104

Source: Calculations

From the calculation of the values of S and G obtained from the following formula:

$$S = \frac{\sum(\log x - \log X)^2}{n-1}$$

$$S = \frac{(0{,}015675)^2}{10-1}$$

$$S = 0{,}00174167$$

TAB.5 Calculation of S

Year	Logx	Log X	∑(Logx-Log X)	2	n-1	S
2010	1,76	1,6348	0,1252	0,015675	9	0,00174167
2011	1,729	1,6348	0,0942	0,0088736	9	0,00098596
2012	1,643	1,6348	0,0082	6,724E-05	9	7,4711E-06
2013	1,653	1,6348	0,0182	0,0003312	9	3,6804E-05
2014	1,539	1,6348	-0,0958	0,0091776	9	0,00101974
2015	1,552	1,6348	-0,0828	0,0068558	9	0,00076176
2016	1,681	1,6348	0,0462	0,0021344	9	0,00023716
2017	1,572	1,6348	-0,0628	0,0039438	9	0,0004382
2018	1,64	1,6348	0,0052	2,704E-05	9	3,0044E-06
2019	1,579	1,6348	-0,0558	0,0031136	9	0,00034596
Total				0,0501996		0,00034596
S						0,00557773

Source: Calculations

Calculation of G :

$$G = \frac{\sum(\log x - \overline{\log x}^3}{(n-1)(n-2)xs^3}$$

$$G = \frac{0,0000104}{(10-1)(10-2)\,0,001963^3} = 0,000591994$$

TAB.6 Calculation of G

Tahun	$\sum(\text{Logx-Log X})^3$	n-1	n-2	xs	^3	$(n-1)(n-2)xs^3$	G
2010	0,00104	9	8	0,2900421	0,0243996	1,75677349	0,000592
2011	0,00104	9	8	0,299	0,0268208	1,93109401	0,0005386
2012	0,00104	9	8	0,2454203	0,0147819	1,06429928	0,0009772
2013	0,00104	9	8	0,250998	0,0158129	1,13852686	0,0009135
2014	0,00104	9	8	0,1933577	0,0072291	0,52049545	0,0019981
2015	0,00104	9	8	0,0086566	6,487E-07	4,6707E-05	22,266525
2016	0,00104	9	8	0,2677312	0,019191	1,38174993	0,0007527
2017	0,00104	9	8	0,2082335	0,0090293	0,65010635	0,0015997
2018	0,00104	9	8	0,2435573	0,0144479	1,0402458	0,0009998
2019	0,00104	9	8	0,2119539	0,0095219	0,68557746	0,001517
S=	0,00055773						
G=	0,000591994						

Source: Calculations

From the results of the slope coefficient G = 0.000591994, the K value for the T-year return period can be obtained by interpolating the prices contained in the attachment, the calculation of K with a 10-year return period is described below.

Data: Coef G (Y) = 0.000591994
Upper limit of coefficient G (A) = Q
Lower limit of coefficient G (C) = -0.1
Upper limit of K(B) = 1.282
Lower limit K(D) = 1.270
The value of K is found by interpolation with equation:

Koef G		Koef K	
A	= 0	B	= 1,282
Y	= 0,000591994	K	= ?
C	= -0,1	D	= 1,270

$$K = B + \frac{(Y-A)}{(C-A)} x (D-B)$$

$$= 1,282 + \frac{(0,00059199-0)}{(-0,1-0)} x (1,270 - 1,282) = 0,01280004$$

TAB.7 The results of the calculation of the value of K for the Log-Person III distribution

No	Repeat time (Tahun)	Y=G	From table		A	C	B	D	K
			Koef	%peluang					
1	2	0,000591999	0 -0,1	0 0,17	0	-0,1	1,282	1,27	1,282071
2	5	0,000591999	0 -0,1	0,842 0,836	0	-0,1	1,282	1,27	1,290073
3	10	0,000591999	0 -0,1	1,282 1,27	0	-0,1	1,282	1,27	1,290073
4	25	0,000591999	0 -0,1	1,751 1,716	0	-0,1	1,282	1,27	1,293398

Source: Calculations

Calculation of the design rainfall logarithm with period T using the formula:
Log XT 10 years = Log X mean + (K x S)
10 year XT log = 1.6348+ (l .290073 x 0.005573)
= 1.641995

XT 10 years = 164,199

TAB.8 Rain probability analysis with Log-person III distribution

No	Repeat Time	$\overline{\log x}$	K	S	Log X_T	Plan Rain (mm)
1	2	1,6348	1,26408	0,005577	1,64185	164,185
2	5	1,6348	1,290073	0,005577	1,641995	164,419
3	10	1,6348	1,290073	0,005577	1,641995	164,199
4	25	1,6348	1,293398	0,005577	1,642013	164,42

Source: Calculations

From the analysis of the distribution of log person type III, the design rain value for the 25 year return period is 164,420 mm.

Frequency Distribution Match Test

The distribution fit test with the Smirnov Kolomogorov test method can be seen in Table 4.15, while Table 4.16 is the result of the Chi Square test calculation.

a. Kolmogorov. srnimov test

Before carrying out the alignment test, first, plotting the data is carried out with the following stages:

- The maximum daily rainfall data for the year is compiled from small to large.
- Calculate probability by formula

$$P = \frac{m}{n+1}\ 100\%$$

Where:
P = Probability (%)
M = serial number of data
n = number of data

$$P = \frac{m}{10+1}\ 100\%$$

= 0.0909

- Plotting discharge data (X) with probability p.
- Draw the duration line by taking 2 points on the Gumbel method (the theoretical line is a straight line) and 3 points on the log person III method (the theoretical line is curved except for cs = 0, the theoretical line is a straight line. The equation used is as follows:

$$\Delta max = [Pe - Pt\ ]$$

Where:
Δmax = maximum difference between probability and theoretical
Pe = empirical probability
Pt = critical deviation

Then compared between max, and the selected frequency distribution is acceptable if max,< and Amaks, > means failure.

Information:
Number of data (n) = 10
Total Log X = 1.76
LogXaverage = 1.634
S = 0.005577
Cs = 3.3031

$$\text{Step 1 } (P) = \frac{m}{n+1}\ 100\%$$

$$= \frac{m}{10+1}\ 100\%$$

$$= 0{,}0909\%$$

Step2 = sort the data from smallest to largest

Step 3 = log X
= 52 = 1.76

Step 4 (G) $= \frac{(\log X - \log X_{rerata})}{S}$

$= \frac{1{,}76-1.6438}{0.005577} = 0.000592$

Step 5 (Pr) = From the Log Person III Distribution Table, with the Interpolation method, the Pr value = 94.9778%

Step 6 (Pt) $= \frac{(100-\text{Pr})}{100}$

$= \frac{(100-94.9778)}{100} = 0.05022$

Step 7 (X^2count) = P(X) – Pt(X)

= 0.0909 – 0.05022 = 0.040687

TAB.9 Smirnov Kolmogorov Test

No	Pe (X)	X (mm)	Log X	G	Pr (%)	Pt (X)	($X^2_{calculation}$)
1	0,090909	34,666	1,76	0,000592	94,9778	0,050222	0,0025222
2	0,181818	35,666	1,729	0,0005386	84,3222	0,156778	0,0245793
3	0,272727	37,333	1,643	0,0009772	80,1448	0,198552	0,0394229
4	0,363636	38	1,653	0,0009135	72,1846	0,278154	0,0773696
5	0,454545	43,333	1,539	0,0019981	48,5623	0,514377	0,2645837
6	0,545455	44	1,552	22,266525	35,4615	0,045385	0,0020598
7	0,636364	45	1,681	0,0007527	30,1089	0,698911	0,4884766
8	0,727273	48	1,572	0,0015997	19,0838	0,809162	0,6547431
9	0,818182	52	1,64	0,0009998	19,0838	0,809162	0,6547431
10	0,909091	53,666	1,579	0,001517	14,9431	0,850569	0,7234676
Total			16,348			Total	2,9319681
logX rate			1,6348			Max	0,09993
Standard deviation (S)			0,005577				
CS			3,3031				

Source: Calculations

Before moving on to the next calculation, the Smirnov Kolmogorov test is carried out with the value of Δmax < Δcr and from the above calculation, the value of Δmax is 0.09993 < Δcr. 0.322, then the distribution of log person III is acceptable.

b) Chi-Square Test

The chi-square test was performed to test the fit of the distribution. The Chi Square (X2) formula is as follows:

$$\sum X^2_{hitung} = \sum_i^k = \frac{(fe-ft)^2}{ft}$$

The price of X^2 with degrees of freedom (n) as above is compared with X^2 in the table with a certain level of confidence (a). if X^2count < X^2, the table means the data corresponds to the distribution in question.

The calculation steps are as follows:

1. The first step is to sort the data in order (from small to large or vice versa), in this analysis the data is sorted from the smallest to the largest.
2. Group the data into K classes, each class at least 4 observational data. Observation of data grouping with the following formula:
   K = 1+3.22 log n
   = 1+3.22 log 10
   = 4.22 taken 4 classes
3. Calculate the class limit with the probability distribution, with the following formula:

$$\frac{100\%}{n} = \frac{100\%}{4} = 25\%$$

4. Calculate the value of X:
   For Pr = 75%, dan Cs = 3,0301. Obtained the value of G= 0,000591999 (from distribution table)
   Log X = Log Xrate + (G+S)

= 1,6348 + (0,000591999 +0,00055773)
= 1,6359
X = 163,59 mm

5. Fe is obtained from the amount of data that enters the class limit
6. Calculate the value of the theoretical / calculated frequency:

Ft = 25Yo x n
= 25% x l0
= 5

7 Calculate X2 with the equation:

$$\sum X_{count}^{2} = \sum_{i}^{k} = \frac{(fe-ft)^2}{ft}$$

8. For class limits (0-163.59), with the amount of data Fe = 3 (in Xurut it is calculated from the amount of rainfall that enters the class limit the amount of data from 0-163.59)

$$\sum X_{count}^{2} = \frac{(fe-ft)^2}{ft}$$
$$= \frac{(3-2{,}5)^2}{2{,}5}$$
$$= 0{,}10$$

9. Calculate the value of chi Square (X^2) for each class, then calculate the total value of X2. The Chi Square value (X^2) of the calculation must be less than the critical Chi Square value (X2 cr) for certain degrees of freedom.

Formula: DK = K – (P + l)
Where:
DK = Degrees of freedom
K = Number of classes(4 classes)
P = Number of attachments;
• P value : 2, for normal distribution and log normal
• P value : 1, for Pearson and Gumbel distribution

DK = 4 – (1 + 1) = 4 – 2 = 2

TAB.10 Average daily maximum annual rainfall data form Chi-Square test

No	Year	Xrate	G	S	X	x100	X(mm)
1	2010	1,6348	0,000592	0,0017	1,637092	100	163,7092
2	2011	1,6348	0,0005386	0,000986	1,6363246	100	163,63246
3	2012	1,6348	0,0009772	7,471E-05	1,63585191	100	163,58519
4	2013	1,6348	0,0009135	0,0000386	1,6357521	100	163,57521
5	2014	1,6348	0,0019981	0,0010197	1,6378178	100	163,78178
6	2015	1,6348	22,266525	7,618E-05	2,90140118	100	23,1401
7	2016	1,6348	0,0007527	0,0002372	1,6357899	100	163,57899
8	2017	1,6348	0,0015997	0,0004382	1,6368379	100	163,68379
9	2018	1,6348	0,0009998	3,004E-06	1,635802804	100	163,58028
10	2019	1,6348	0,001517	0,000346	1,636663	100	163,6663

Source: Calculations

TAB.11 Average daily maximum annual rainfall data form Chi-Square test

No	Pr	Average Log X	CS	G	S	x100	X (mm)
1	75	1,6348	3,0301	0,000592	0,005577	100	164,0969
2	50	1,6348	3,0301	0,0005386	0,005577	100	164,09156
3	25	1,6348	3,0301	0,0009772	0,005577	100	164,13542

Source: Calculations

Land Use Coefficient
Based on the land use function, the land use coefficient in channel A is as follows:

TAB.12 Land Use Coefficient

No	Flow Area Condition	Flow Coefficient (C)
1	Grass	0,05 – 0,35
2	Business	0,50 – 0,95
3	Housing	0,25 – 0,75
4	Industry	0,50 – 0,90
5	Garden	0,10 – 0,25
6	Playground	0,20 – 0,35
7	Mountain area with steep slopes	0,75 – 0,90
8	Hilly area	0,70 – 0,80
9	Bumpy and bushy ground	0,50 – 0,75
10	Cultivated plain land	0,45 – 0,65
11	Irrigated rice fields	0,70 – 0,80
12	River in the mountains	0,75 – 0,85
13	Small river in the plains	0,45 – 0,75
14	A large river with a flow area of more than half of the plains	0,50 – 0,75

Source: data analysis

Housing 0.25, with an area of 20310 m^2
Irrigation Rice Fields 0.70, with an area of 140907 m^2
For other channel Cdas calculations seedas
By using the formula C as follows:

$$C_{das} = \frac{20310x0{,}25 + 140907x0{,}70}{20310 + 140907}$$

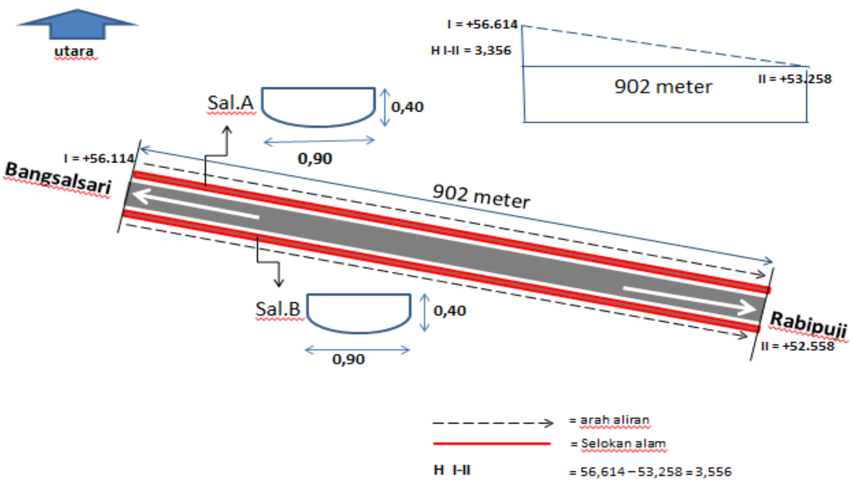


Figure 2: Land Use Map

The determination of the slope of the channel bottom is attempted to follow the slope of the surface of the soil contour in the design area. Example calculation on channel 1A with the following data:
L = 902 meter, ΔH =3,556 meter

$$I = \frac{\Delta H}{L} = \frac{3{,}556}{902} = 0{,}0037171$$

Square Channel Dimension Planning
As for the evaluation of the drainage network on Jalan Raya Pecoro, it must first know the maximum discharge that can be accommodated by the existing channel. If the maximum discharge of the existing channel

is less than the planned discharge. To calculate the maximum discharge in the channel by looking at the direction of the water from the channel, when a stream gets another channel flow, the flow rate of the previous channel is added first.

To determine the dimensions of the existing rectangular channels A and B, among others:

1. The width of the base of the channel (b) is the width of the base of the existing channel: 0.80 - 0.90 meters
2. Flow depth (h) is the vertical distance of the lowest point on a channel cross section to the free surface = 0.35 - 0.40 meters
3. The peak width (T) is the cross-sectional width of the channel on the free surface, because the channel is square
   so the value of T = b = 0.90
4. The area of the location from the figure shows the area of water flowing into the upper channel of 0.0064 m^2, while for the lower one it is = 0.0036 m^2.

Figure 3: Area (A)

5. Wet area (A) is the cross-sectional area of the flow perpendicular to the flow direction.
   A = b x h
   = 0.90m x 0.70m
   = 0.63 m^2
6. Wet circumference (P) is the length of the line of intersection of the wet surface of the channel with the cross-sectional plane perpendicular to the flow direction.
   P = b + 2h = 0.90 + (2) 0.70 = 2.3 meters
7. Hydraulic radius (R) is the ratio of wet area to wet circumference
   $$R = \frac{A}{P} = \frac{0{,}63}{2{,}30} = 0{,}27\ m$$
8. According to the existing data of the channel wall using soil with unfavorable conditions, the value of the maning roughness coefficient is n = 0.030
9. In evaluating the drainage system on the Pecoro Highway channel A and B, the flow velocity uses the manning method with the following equation:
   V = Speed of flow in the channel (m/s)
   n = Manning roughness coefficient = 0.025
   R = Hydraulic radius = 0.15
   I = channel bottom slope : 0.0037171.
   $$V_x = \frac{1}{n} x R^{2/3} x S^{1/2}$$
   $$V_x = \frac{1}{0{,}02} x 0{,}27^{2/3} x 0{,}005^{1/2} = 1{,}48\ m/s$$
10. To determine the type of flow is the ratio between the gravitational force and the inertia force, which is expressed by the Froude number (Fr). The Froude number is defined as follows.
    V = flow rate (m/s)
    h = depth of flow (m)
    g = acceleration due to gravity (rn/s)
    $$F_r = \frac{V}{\sqrt{gh}} = \frac{1{,}246}{\sqrt{9{,}18 x 0{,}40} = 0{,}604}$$

11. Determine the debit of each channel with the formula:
    A = Wet cross-sectional area = 0.63 m^2
    V = Flow velocity in channel = 1.48 m/s
    In planning the network and drainage channels, it is necessary to first know the maximum design discharge with a certain birthday period and the researchers here plan the maximum discharge for 10 years, from this discharge the dimensions of the channel can be planned. For the dimensions of the channel using a rectangular channel, the following calculations are made:
    In this study the flow velocity using the float method with the calculation of Q_1 as follows:
    Q = A x V
    = 0.63 x 1.48 = 0.93 m^3/s

Average Rain Intensity

Rain intensity (mm/hour) can be derived from empirical daily rainfall data (mm) using the mononobe method, rainfall intensity (l) in a rational formula can be calculated based on the formula:

$$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{2/3}$$

Where:
I = rainfall intensity (mm/jarn)
R_{24} = local design rainfall. 25 year design rainfall = 163.7092 mm
T = duration of rainfall (0.528 hours)

$$I = \frac{163.5852}{24}\left(\frac{24}{0{,}528}\right)^{2/3}$$
$$I = 86{,}783$$

Plan Flood Discharge
Rational Method Equation with example calculation on channel lA saluran as follows :
Q = Maximum flood discharge (m3/s)
C = Flow coefficient
I = Average rainfall intensity (mm/hour)
Rain intensity for 10 years = 86.783 mm/jarn
A = Area of drainage area (km2)
Q_2 = 0.2778 . C . I . A
= 0.2778 x 0.7 x 86.783 x 0.0064
= 0.10 m^3/sec
Q_3 = 0.2778 . C . I . A
= 0.2778 x 0.7 x 86.783 x 0.0036
= 0.60 m^3/sec
In this study the flow velocity using the float method with the calculation of Q1 as follows:
Q_1 = A x V
A = B x H x V = 0.9 x 0.7 = 0.63 x 0.25
Q_1 = 0.157 m^2/s
Calculation of Q1 + Q2 and Q1 + Q3
Upper Channel = Q1 + Q2
= 0.157+ 0.10
= 0.257 m3/sec
Channel = Q1 + Q3
= 0.157 + 0.60
= 0.757

TAB.13 Channel Dimension Calculation

No	Channel	B	H	A	P	R	S	V	Q cross-section hood	discarded Q	Information
		m	m	m^2	m	m		(m/s)	m^3/s	m^3/s	
1	Upper	0,9	0,7	0.63	2,30	0,3	0,005	1,48	0,93	0,257	Safe
2	Under	0,9	0,7	0.63	2,30	0,3	0,005	1,48	0,93	0,257	Safe

Source: Calculations

Planned:
B = 0.9 m
H = 0.7 m
A = B.H = 0.9..0.7 = 0.63 m^2
P = b + 2h = 0.90 + (2) 0.70 = 2.30 m

R = A/P = 0.63 / 2.30 = 0.27 m

V = 1/n . $R^{2/3}$. S1/2

= 1/0.02 x $0.27^{2/3}$ x $0.005^{½}$ = 1.48 m/s

Q channel = A .V = 0.63 x 1.48 = 0.93 m^3/s

Then from the calculation of the existing square channel, the calculation of the dimensions of the new square channel can be seen in Figure 4. below.

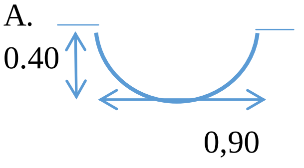
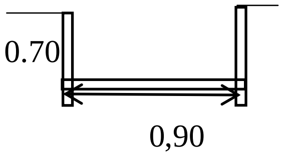
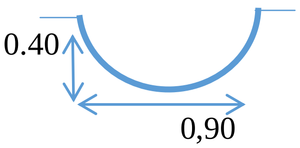
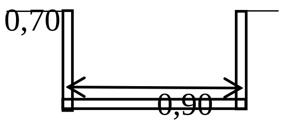
<table>
<tr><th>CHANNEL (EKSISTING)</th><th>CHANNEL PLAN</th><th>EXISTING CHANNELS PHOTO</th><th>INFORMATION</th></tr>
<tr><td>A.

</td><td>
</td><td></td><td>SAFE</td></tr>
<tr><td>B.

</td><td>
</td><td></td><td>SAFE</td></tr>
</table>

Figure 4: Existing and Planned square channel

IV. CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the evaluation and calculation results of the discussion, it can be concluded as follows.

1. The planned flood discharge that occurred in the Jember – Surabaya National Road section in Pecoro Village, Rambi Puji District, Jember Regency, for a 10 year return period is 0.757 m3/s.
2. For the results of the calculation of the re-planning of the drainage channel dimensions the results are as follows: channel depth (H) = 70 cm and bottom width (B) = 90 cm guard height 30 cm, and foundation thickness 30 cm

Suggestion

Based on the conclusions above, the following can be suggested.

1. The road drainage here also requires maintenance so that the drainage functions properly so that it can minimize the volume of water discharge that enters the highway
2. Efforts to overcome flooding in the catchment area must be carried out spontaneously by people who are active around the cathment area so as not to litter.

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