Journal of Science Innovare
https://journal.unpak.ac.id/index.php/jsi

Volume 02, Number 02, September 2019, Page 40-43
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

REVIEW OF ROAD DRAINAGE SYSTEM (CASE STUDY: JALAN CIGOMBONG KM 16 - KM 23)

Yahya Azura [a)], Heny Purwanti [a*)], Wahyu Gendam Prakoso [a)]

[a)] *Universitas Pakuan, Bogor, Indonesia*
[*)] *Corresponding Author: henny.purwanti@gmail.com*

Article history: received 18 July 2019; revised 27 July 2019; accepted 25 August 2019

Abstrak. A good road drainage system is needed to ensure that road user activities are not disrupted due to rain puddles. The cause of inundation that occurs is land use change, there is no drainage channel, the channel is not well connected, the channel is closed due to widening of the road without considering drainage channels. Given this, research needs to be carried out on the condition of the existing drainage system as a material consideration for evaluating its feasibility and planning a drainage system that is able to overcome the inundation that occurs. Writing this final project refers to primary data and secondary data that already exist. The rainfall data came from the Climatology and Geophysics Meteorological Agency, Balai Besar Region II, Bogor Regency, which is the Darmaga huajn rainfall measurement station and the PUPR Binamarga Office of Bogor Regency. Meanwhile, to find out the dimensions of the existing drainage channels obtained by conducting surveys and direct observation to the field. Data analysis which was carried out was hydrological and hydraulics analysis. Hydrological analysis includes the analysis of rainfall frequency, determining the repeat period, calculating the concentration time, analyzing the rainfall intensity, and calculating the flow flow plan. Based on the results of hydrological analyzes, the hydraulics analysis is then performed, such as calculating the plan channel profile and calculating the height of the planned channel guard. From all of these analyzes, the results of the drainage study on the Cigombong KM 16 - KM 23 highway were carried out, that is, the entire capacity of the existing canals was not able to accommodate the planned flow discharge for a return period of 2 years 5 years 50 years. In addition, the results of the analyzes that have been carried out show that the rain that occurs during a certain period of time and a certain return period greatly affects the planned drainage channel profile and is due to the large amount of garbage in the channel which affects the reservoirs in the drainage that often occur frequently..

Keywords: hydrological analysis; hydraulic analysis; road drainage; drainage evaluation; drainage studies

I. INTRODUCTION

Drainage canal is one of the complementary buildings on the road in meeting one of the technical requirements of road infrastructure. The drainage channel of the highway serves to drain water that can disturb road users, so that the road conditions and road construction remain dry and good. In general, a highway drainage channel is an open channel using the force of gravity to drain water toward the outlet. The distribution of flow in the drainage channel to this outlet follows the contour of the highway, so surface water will flow more easily by gravity.

The more developed an area, the open land to absorb water naturally will decrease. Soil surface covered by concrete and asphalt, this will add excess water that is not wasted. This excess water if it cannot be drained will cause inundation. In planning the drainage channel, it must pay attention to the land use of the drainage water catchment area which aims to keep the road segment dry even if there is excess water, so that surface water remains controlled and does not interfere with road users **[1]**.

Inundation on roads is still common in several cities, especially densely populated cities. Inundation on the road will disturb the people who use the road to carry out economic activities. If the problem of inundation is not resolved, it can be possible to cause damage to road construction which results in obstruction of the motorized vehicle lane.

Cigombong Highway is one of the roads in Bogor Regency that still often experiences inundation due to drainage channels that cannot accommodate or drain surface water. Based on these problems, this research needs to identify the cause of the Cigombong Highway channel that is not functioning optimally so that the solution to the problem can be determined **[2]**.

Drainage which comes from the verb 'to drain' which means to drain or drain water, is a term used to express systems related to handling the problem of excess water, both above and below the surface of the excess water can be caused by the intensity high rain or due to a long duration of rain. In general drainage is defined as science that studies efforts to drain excess water in a particular user context. Azawaruddin **[3]**.

Drainage types can be divided into two types, namely:

Natural Drainage

Drainage that is formed naturally and there are no supporting buildings such as overflow buildings, masonry/ concrete pairs, culverts, and others **[4]**. This channel is formed by a scour of water that moves due to gravity which

Volume 02, Number 02, September 2019, Page 40-43
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

gradually forms a permanent waterway like a river. In this type of drainage drying occurs without human intervention.

Artificial Drainage

Drainage that is made with a specific purpose and purpose so that it requires special buildings, both open and closed channels and other regulating buildings.

Algebra Method. Average height of rainfall is obtained by taking the average value of the count (arithmetic mean) of dosing in the rain gauge area (Soemarto **[5]**). Thiessen Polygon Method. This method is done by plotting the location of rainfall stations into the drawing of the relevant drainage area. Then a connecting line is made between each station and a perpendicular axis is drawn (Soemarto **[5]**). The return period is the drainage channel that accommodates rainfall that is expected to occur once in a certain period of time, for example 2, 5, 10, 15 or 25 years depending on the function of the building. The frequency of rain is the possibility of repetition of events or return periods of rainfall, run off, or flood planning, The drainage area is often also referred to as the catchment area. To get the drainage area that represents reality in the field, the following data / information is used. Map of drainage areas from related agencies or GIS maps consisting of contour layers, roads, rivers / canals, buildings and inundation areas, aerial image files, field information, channel survey results. Concentration Time is the time required by the raindrops on the surface of the ground and flows to the observed point.

Rainfall intensity is the height of rainfall that occurs at a time period where the water is concentrated. Based on the analysis of rainfall intensity, duration, and frequency, the relationship between the three is obtained in the form of an IDF (Intensity Duration Frequency) curve graph. The graph is used to determine the intensity of rain at a certain return period and a certain concentration time. Flow coefficient is a variable based on the condition of the drainage area and the characteristics of the rain that falls on the area. The conditions and characteristics in question are rain conditions, area, shape of the drainage area, slope of the flow area,

II. RESEARCH METHODS

Harbor The time for this final project research took place in September 2018 until May 2019. The research location was located in the corridor JL. Raya Cigombong - Caringin KM 16 - KM 23 located in the Districts of Cigombong and Kec Caringin, Bogor Regency.

Condition and Drainage Problems in the Study Area

1. On the left and right sides of the Caringin and Cigombong highways are generally densely populated areas of trade and settlement activities.
2. Channels from residential areas on the South and North sides are many that join the edge of the caringin highway and Cigombong highway, before entering the main channel (river).
3. The pattern and dimensions of settlement channels on the South and North sides of the Caringin and Cigombong highways do not have a neatly arranged network with a uniform channel size according to the needs of runoff, where the network and size have not been handled.
4. In plain view, all the Caringin highway and Cigombong roadways on the left and right sides of the road can be said to be more than 50% physically damaged, shallow, and filled with garbage dumps. So that with sufficiently high rainfall, runoff will overflow over the channel and inundate the area around the road.
5. Rainfall. Bogor Regency is an area that has a very high rainfall intensity, so Bogor is known as the city of rain. Average maximum rainfall in the Bogor Regency reaches 100-200 mm/hour/year **[6]**.

The rainfall data used is taken from the nearest rainfall station, the Pondok Indah Caringin rainfall measuring station. The Darmaga Bogor Rainfall Measuring Station is under the management of the Bogor Regency's Bina Marga and Irrigation Service Office. The data obtained in the form of maximum daily rainfall data for the last 10 years, namely from 2008 to 2017. The data will be needed in drainage planning, because it is related to runoff water flow that will flow in the channel.

III. RESULTS AND DISCUSSION

Table 1. Maximum Daily Rainfall Used

No.	Year	Month	Maximum Daily Rainfall (mm)
1	2008	March	494,00
2	2009	November	536,00
3	2010	March	642,00
4	2011	March	422,00
5	2012	December	550,00
6	2013	January	479,00
7	2014	November	644,00
8	2015	December	438,00
9	2016	March	523,00
10	2017	February	473,00

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Table 2. Maximum Daily Rainfall Used

No.	Year	Month	Maximum Daily Rainfall (mm)
1	2008	November	536,00
2	2009	May	530,00
3	2010	March	568,00
4	2011	June	358,00
5	2012	February	562,00
6	2013	January	754900
7	2014	December	579,00
8	2015	March	360,00
9	2016	February	512,00
10	2017	March	400,00

Volume 02, Number 02, September 2019, Page 40-43
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

Table 3. Maximum Daily Rainfall Used

No.	Year	Month	Maximum Daily Rainfall (mm)
1	2008	March	551,00
2	2009	January	607,00
3	2010	February	625,00
4	2011	May	334,00
5	2012	April	465,00
6	2013	May	650,00
7	2014	January	802,00
8	2015	March	520,00
9	2016	February	528,00
10	2017	January	464,00

The re-selection period is based on design standards that have been approved in SNI 03-3424 in 1994. In the data analysis conducted, the planned return period is 2 and 5 years. Frequency analysis of rainfall data is carried out using several methods, namely Normal distribution, Normal Log distribution, Pearson Log III

Table 4. the data analysis conducted

No.	Re-Period	Normal distribution	Normal Log Distribution	Pearson III Log Distribution
1	2 tahun	554,60	537,03	537,03
2	5 tahun	661,15	616,59	645,65
3	50 tahun	814,64	741,31	851,13

Regional Flowing

Table 5.Stream area

No.	Segmen	P (m)	Jalan Raya Cigombong				Permukiman			
			Selatan		Utara		Selatan		Utara	
			L_0 (m)	A (m2)	L_0 (m)	A (m2)	L_0 (m)	A (m2)	L_0 (m)	A (m2)
1	A	600,00	5,00	3000,00	5,00	3000,00	100,00	54438,00	100,00	47502,00
2	B	690,00	5,00	3450,00	5,00	3450,00	100,00	50784,00	100,00	64239,00
3	C	800,00	5,00	4000,00	5,00	4000,00	100,00	83320,00	100,00	70880,00
4	D	650,00	5,00	3250,00	5,00	3250,00	100,00	58708,00	100,00	54983,50
5	E	700,00	5,00	3500,00	5,00	3500,00	100,00	73514,00	100,00	69279,00
6	F	550,00	5,00	2750,00	5,00	2750,00	100,00	40392,00	100,00	42476,50
7	G	850,00	5,00	4250,00	5,00	4250,00	100,00	81175,00	100,00	83725,00
8	H	550,00	5,00	2750,00	5,00	2750,00	100,00	41492,00	100,00	50297,50
9	I	460,00	5,00	2300,00	5,00	2300,00	100,00	28303,80	100,00	37241,60
10	J	780,00	5,00	3900,00	5,00	3900,00	100,00	78936,00	100,00	78000,00
11	K	470,00	5,00	2350,00	5,00	2350,00	100,00	30879,00	100,00	33158,50
12	L	900,00	5,00	4500,00	5,00	4500,00	100,00	91440,00	100,00	87840,00

Hydraulics Analysis

The planned channels, namely:

1. The shape of the channel adjusts to the existing condition, which is rectangular. 2. Channel width and water level are planned with the same dimensions, i.e. b = h. 3. Made of reinforced concrete, both the channel wall and the base of the channel. 4. Channel capacity is calculated based on the equations specified in SNI 03-3424 of 1994,

Table 6. High regulator wall South Side Plan

No.	Segmen	h (m)			h_j (m)		
		2 year	5 year	50 year	2 year	5 year	50 year
1	A	0,14	0,16	0,18	0,27	0,28	0,30
2	B	0,13	0,15	0,17	0,26	0,27	0,29
3	C	0,16	0,18	0,21	0,29	0,30	0,32
4	D	0,15	0,16	0,18	0,27	0,28	0,30
5	E	0,16	0,18	0,20	0,28	0,30	0,32
6	F	0,13	0,14	0,16	0,25	0,26	0,28
7	G	0,16	0,18	0,20	0,28	0,30	0,32
8	H	0,13	0,14	0,16	0,25	0,26	0,28
9	I	0,11	0,12	0,14	0,24	0,25	0,26
10	J	0,16	0,18	0,20	0,28	0,30	0,32
11	K	0,11	0,13	0,14	0,24	0,25	0,27
12	L	0,17	0,18	0,21	0,29	0,30	0,32

Table 7 Height of the wall of the North Side Plan Channel

No.	Segmen	h (m)			h_j (m)		
		2 year	5 year	50 year	2 year	5 year	50 year
1	A	0,13	0,15	0,17	0,26	0,27	0,29
2	B	0,15	0,16	0,19	0,27	0,29	0,31
3	C	0,15	0,17	0,19	0,28	0,29	0,31
4	D	0,14	0,16	0,18	0,27	0,28	0,30
5	E	0,16	0,17	0,20	0,28	0,29	0,31
6	F	0,13	0,14	0,16	0,25	0,27	0,29
7	G	0,16	0,18	0,21	0,29	0,30	0,32
8	H	0,14	0,15	0,18	0,26	0,28	0,30
9	I	0,13	0,14	0,16	0,25	0,26	0,28
10	J	0,16	0,18	0,20	0,28	0,30	0,32
11	K	0,12	0,13	0,15	0,24	0,25	0,27
12	L	0,16	0,18	0,21	0,29	0,30	0,32

Drainage Channel Evaluation

The dimensions of the existing channel must be able to flow the design discharge, i.e. the discharge flowed by the existing channel is equal to or greater than the planned discharge. Example evaluation for segment A on the South side:

1. For a 2-year return period

a. Data is taken which are:

QE = 0.36m3 / sec

QR = 0.06 m3 / sec

b. QE ⩾ QR

0.36 m3 / sec ⩾ 0.06 m3 / sec

c. Because QE is greater than QR, the dimensions of the existing channel are sufficient to accommodate the planned discharge for the 2-year return period.

2. For a 5-year return period

a. Data is taken which are:

QE = 0.36 m3 / sec

QR = 0.07 m3 / sec

b. QE ⩾ QR

0.36 m3 / sec ⩾ 0.07 m3 / sec

Volume 02, Number 02, September 2019, Page 40-43
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

c. Because QE is greater than QR, the dimensions of the existing channel are sufficient to accommodate the 5 year return period discharge plan.

3. For a 50 year return period

a. Data is taken Data is taken which are:

QE = 0.36 m3 / sec

QR = 0.10 m3 / sec

b. QE ⩾ QR

0.36 m3 / sec ⩾ 0.10 m3 / sec

c. Because QE is greater than QR, the dimensions of the existing channel are sufficient to accommodate the 50 year return period discharge plan

IV. CONCLUSION

Based on the results of discussions that have been carried out on the KM 16 - KM 23 highway cigombong drainage system, several conclusions are obtained, including:

1. Based on the analysis of rainfall frequency plans using four distribution methods, namely Normal distribution, Normal Log, Pearson III Log, obtained the largest calculation of the Log Person III distribution method, namely X2 years = 537.03 mm. X5 years = 645.65 mm. X50 years = 851.13 mm.

2. Rainfall intensity used is the rainfall intensity from the reading of the IDF (Intensity Duration Frequency) curve graph for the time concentration of the Tc plan.

3. Based on the results of the analysis, the basic channel slope of the planned plan still fulfills the maximum allowable channel base slope requirements.

4. High guard channel is planned to be able to prevent water overflow due to waves and water surface fluctuations, for example in the form of wind movements or tides.

5. The results of the analyzes show that rain that occurs during a certain period of time and a certain return period greatly affects the profile of the drainage channel.

6. As a result of the lack of awareness of the people who live around the KM 16 - KM 23 Cigombong highway that dumps garbage into the drainage channel which results in clogging and silting which results in inundation and flooding.

7. When re-analyzing the drainage of KM 16 - KM 23 Cigombong highway, no effect was found due to the construction of the Bocimi toll road.

8. Permission speed that does not meet is handled by making a drop structure.

Based on the results of research conducted in the field, we get some suggestions that can be used for the future. looking for a composite C value using an geographic information system application.to get accurate results. To overcome the inundation on the cigombong KM 16 - KM 23 highway, dredging of the existing drainage canals so that the drainage can flow through the water discharge properly. For further research, it is better to take into account the waste water that enters the drainage system. It is necessary to carry out maintenance of existing drainage in the form of repairing channels and dredging sediment periodically. This was done to avoid siltation of channels caused by garbage or waste from the surrounding community. Housing and settlement development around the study area must pay attention to the impact of environmental conditions caused by development activities. The impact can be in the form of reduced water catchment areas.

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