ISSN No:-2456-2165

Study of Network System and Capacity of Bangkala Drainage Channels in 5 Makassar

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Abstrac:- Wilayah Perumnas Antang especially Jl. Bangkala In 5 Manggala Villages Of Manggala District of Makassar City, which is one of the areas where there is often puddles because the existing channels in the drainage system are not able to drain rainwater capacity so that rainwater is pumped into the road,itisalsocaused by the low topography and condition of the channel. not well connected to the study site. This study aims to find out how much rainwater runoff discharge and how the effect of runoff discharge on the capacity of Jl. Bangkala drainage channel in 5 Makassar City. The planned rainfall analysis calculation method uses the Pearson Type III Log Method using the average maximum daily rainfall in an algebraic average manner. For calculationn discharge plan uses Rational Method while for hydraulic analysis uses continuity formula. The results of this study showed that the results of the analysis obtained the highest channel Q is on *Loop* C point C1-C2:0.1050 m^3/ second and the lowest channel Q ison *Loop* A point A2-A3:0.0309 m3/ second. Where the condition of the channel system on *Loop* C point C1-C2 can still drain water discharge and on *Loop* A point A2-A3 is no longer able to drain water discharge. Afew solutions that can be done to overcome the problem include changes in the dimensions of the channel and the manufacture of catchment wells.

Keywords:- *Drainage, Rainfall, Runoff.*

I. INTRODUCTION

The rapid population growth of Makassar City is not directly proportional to the development of its infrastructure so that the reduction of rainwater catchment areas, watertight land will cause limited infiltration and perlocation in the soil, causing more water to be transformed into surface runoff.

Perumnas Antang area, especially Jl. Bangkala in 5 Manggala Village, Manggala District, Makassar City, which is one of the areas where there is often puddles because the channels in the drainage system are not able to drain rainwater capacity so that rainwater is pumped into the road. The problem is also caused by low topography and the condition of channels that are not well connected to the study site so that it becomes one of the causes of inundation. So that every rainy season water from overflowing drainage channels flood roads and houses around drainage channels so that it impacts from discomfort while on the move and has an impact on health problems such as the difficulty of clean water, and residents' activities become hampered.

Structuring and improving the efficiency of the city's drainage network, especially in Jl. Bangkala in 5 Makassar Cities needs to be done as soon as possible so that the flood problem can be addressed immediately. Therefore, studies are needed to evaluate existing drainage channels and networks as well as proper and sustainable planning.

II. THEORETICAL STUDIES

A. Drainage

Urban drainage is one of the engineering efforts undertaken to reduce excess water, both from rainwater, seepage, and excess irrigation water from an undisturbed area / land [1]

B. Drainage Function

Drainage in the city has the following functions [2]

- To drain puddles or floods or rainwater quickly from the road surface.
- To prevent the flow of water coming from other areas or areas around roads that enter the pavement area of the road.
- To prevent road and environmental damage caused by standing water and roads.

C. Rainfall Analysis

The amount of rain that occurs in a watershed is a very important amount in the watershed system, because rain is the main input into a watershed. Then the measurement of rain should be done as carefully as possible. To obtain data or forecasts of the amount of good rain occurs in a watershed, a number of rain stations are needed. [3]

D. Hydrological Analysis

Hydrology is the science related to the earth's water, both regarding its occurrence, circulation and spread, its properties and its relationship to its environment especially with living things. Hydrological analysis is a very complex and complex field. This is due to the uncertainty of the hydrological cycle, data recording and data quality. [3]

E. Selection of Distribution Functions

Momentary flood discharge data from observations > 20 years is made histogram that forms a curve and try to be approached with one of the distribution functions such as: Normal distribution, Normal Log, *Pearson Log,* Gumbel and

ISSN No:-2456-2165

others. The distribution function closest to the observation data is used to calculate the magnitude of the flood/rain plan [4]. Testing of the relationship between the obseration data distribution function and the selected distribution function can use the *Chi-Square* or *Kolmogorov-Smirnov*tests. [4]

F. Rain Intensity Analysis

The intensity of rain height is set as a planning price that pays attention to the re-period calculated by methods prevalent in hydrological analysis [5]. Concentration time (tc) is the time required by the point of rainwater falling farthest at ground level in the Catchment Area to the nearest channel (to) and plus time to flow to a point in the drainage channel reviewed (td) (Ministry of Public Works Directorate Jendreal Cipta Karya, 2013). The intensity of rain height is set as a planning price that pays attention to the re-period calculated by methods common in hydrological analysis (SNI 8456:2017). According to Dr. Mononobe if the existing rainfall data is only daily rainfall. Formula used:

$$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{\frac{2}{3}} \qquad \ldots 1$$

G. Design Debit With Rational Methods

Urban drainage plan discharge is calculated by a rational method that has been modified and/or *typical hydrogram for urban areas.* The coefficient of run*off*is determined based on the land useof catchment areas (Regulation of the Minister of Public Works of the Republic of Indonesia Number 12/PRT/M/2014 concerning the Implementation of Urban Drainage Systems). Here is the formula *modified rational method* or rational *method* modified equation as follows:

$$Q = 0.00278.C.I.A \qquad \ldots 2$$

H. Waste Water Discharge

Calculation of domestic wastewater discharge sourced from settlements can be done using a population approach to the use of drinking water that becomes domestic wastewater in each service block. The percentage of domestic wastewater incidence is 60-80% of the use of drinking water, so that the equation that can be used is:

$$Q_{\boldsymbol{wastewater}} = (60 - 80\%)\ x\ Q_{drinking\ water} \qquad \ldots .3$$

I. Hydraulic Analysis

Determination of the dimensions of existing (existing) or planned channels, based on the maximum discharge to be streamed. The formula used is:

Q = A . V ……4

III. STUDY METHOLOGY

A. Location of Study

This research was conducted at St. Bangkala In 5 Manggala Districts of Manggala Village, Makassar City, South Sulawesi Province. Housing development in Jl. Bangkala In 5 and surrounding areas is not accompanied by the loading of drainage systems andthe eruption of residential areas is often flooded so that drainage improvement needs serious attention.

Fig 1:- Research location(Bangkala Street In 5)

B. Type of Research

This type of research is descriptive, which is a type of research that aims to portray the phenomenon that is the focus or object of research. Descriptive research is research that intends to make depictions of situations or events. The methods used are field surveys and literature surveys.

C. Data Collection Techniques

➢ *Primary Data*

- The cross-sectional shape of the channel is directly measured on the ground.
- Channel dimensions include the width of the upper cross-section, the width of the bottom cross-section and the height of the channel.
- Land use condition data includes the level of damage to construction conditions on the channel
- Elevation data retrieved using *Google Earth Pro* app

➢ *Secondary Data*

Secondary data obtained from library materials relevant to this research and related institutions include the Public Works Office which includes:

- Daily rainfall data for at least the last 22 years with 3 rainfall station posts, among others, Tanralili post, Malino post, Panakukang post
- Map data: territorial boundaries, land use maps and green open spaces
- Housing data: number of homes, population, percent of wastewater

D. Analysis of Hydrological and Hydraulic Data

Hydrological data that has been obtained is further analyzed to determine the discharge of runoff in the drainage channel. The steps of hydrological analysis consist of:

- Rainfall analysis plan
- Analysis of maximum rainfall statistical parameters
- Selection of spread types
- Analysis of rainfall plans with various repeat times
- Spread match test
- Analysis of rainfall intensity (I)
- Concentration time analysis (tc)
- Analysis of draft discharge with rational methods
- Analysis of wastewater plants

The steps of hydraulic analysis consist of:

- Analysis of the dimensions of drainage channels
- Analysis of drainage discharge capacity with Manning equation

IV. RESULT OF RESEARCH AND DISCUSSION

A. Hydrological Analysis

➢ *Analysis of average rainfall - maximum average*

This method uses an algebraic calculation of average, high rainfall taken from the average price of the observation station within the area reviewed. Then, after the maximum rainfall data is obtained, then the data is averaged. For calculation analysis can be seen in table 1.

Year	Malino Post	Panakkukang Post	Tanralili Post	$\bar{R}$ (mm)
1999	185	235	132	184.00
2000	118	376	227	240.33
2001	0	200	122	107.33
2002	125	161	129	138.33
2003	163	210	49	140.67
2004	137	128	121	128.67
2005	82	141	89	104.00
2006	220	110	110	146.67
2007	135	97	160	130.67
2008	75	181	53	103.00
2009	93	113	0	68.67
2010	96	91	0	62.33
2011	133	90	0	74.33
2012	17	115	114	82.00
2013	275	193	255	241.00
2014	125	135	114	124.67
2015	119	139	146	134.67
2016	87	142	121	116.67
2017	135	178	162	158.33
2018	149	145	109	134.33
2019	201	125	390	238.67
2020	0	160	0	53.33
Total				2912.67
Average				132.39

Table 1:- Average rainfall Bangkala Street In 5 in 1999-2020

➢ *Distribution Type Selection*

After the data parameters G, Ck, and Cv are obtained, then connected with the conditions that have been determined. From the results of the analysis for determining the method of distribution type that meets is log Pearson Type III.

B. Analysis of Rainfall Design With Various Repeat Times (T)

Method	**Re-time**			
	2 years	**5 years**	**10 years**	**25 years**
Pearson Type III Log	122,1981	173,5087	208,3302	253,1206

Table 2:- Analysis of rainfall with various repeat times (T)

C. Analysis of Rainfall Intensity (I)

Analysis of rainfall intensity using the Formula Dr. mononobe based on the interval of concentration time every hour starting from 5 minutes. For calculation of the analysis of rainfall intensity design using the equation (1) can be seen as follows:

For 2 years of birthdays every 5 minutes:

$$I = \frac{122.1981}{24}\left(\frac{24}{\frac{5}{60}}\right)^{\frac{2}{3}} = 221.2119\ mm/hour \qquad (1)$$

For the next 5-year birthday each minute can be seen in figure 2.

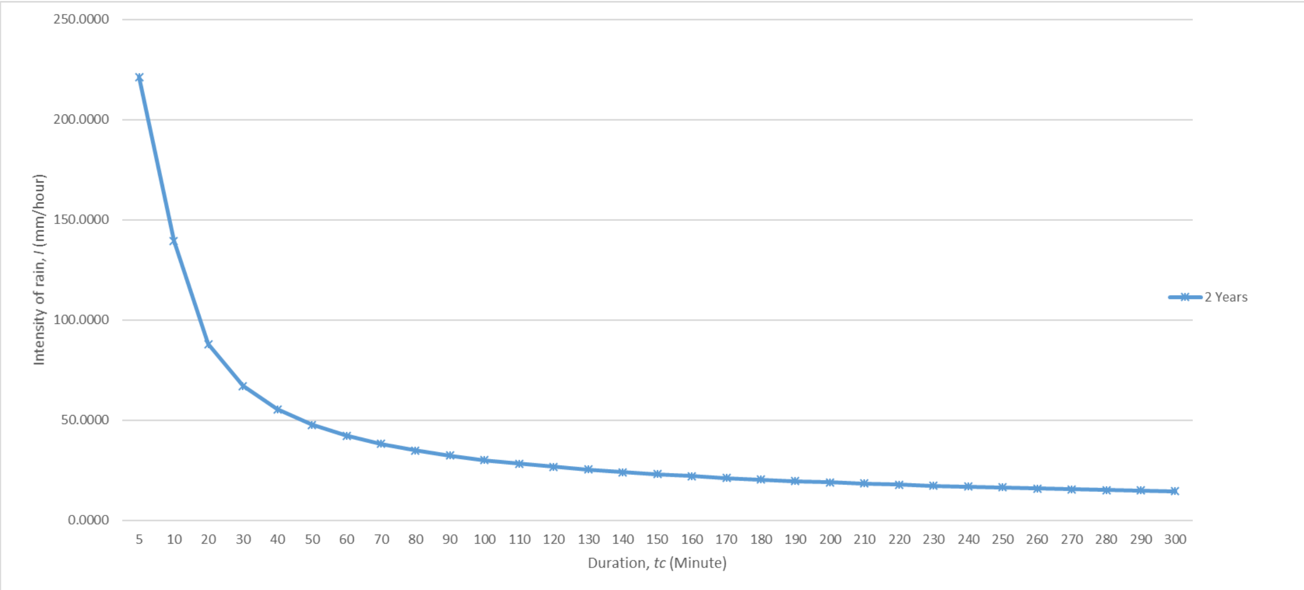

Fig 2:- Graph of rainfall intensity relationship for 2-year re-concentration

D. Flow Concentration Time Analysis (tc)

The length of rain (time of concentration) tc here is considered the length of rain that will cause flood discharge and t is calculated by kirpich equation, namely:

$$tc = \left(\frac{0.06628\ x\ 19.95^{0.77}}{0.16^{0.385}}\right) = 1{,}345093\ hour$$

E. Plan Debit Analysis (Qrunoff)

From Figure 1. Grafik Relationship Of Rainfall Intensity Analysis when repeating 2 years obtained tc value So that obtained Rainfall Intensity I = 34.77 mm / hour. The determination of the discharge of this final task design uses rational methods. So for the determination of the design discharge can be seen figure 3

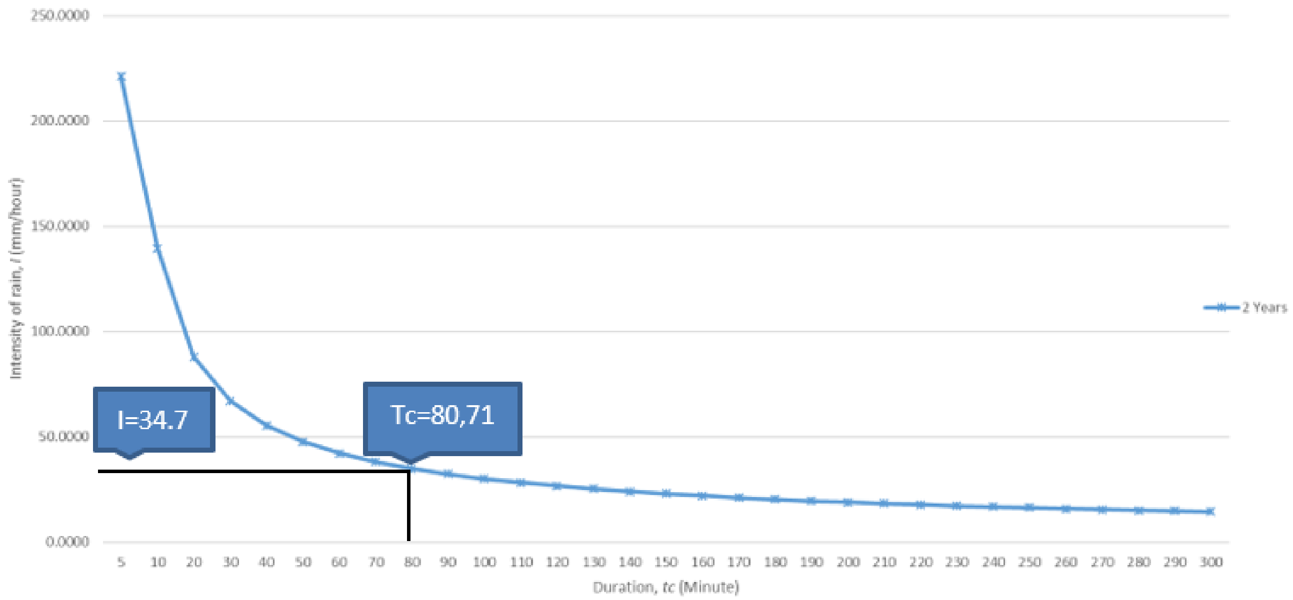

Fig 3:- Graph of rainfall determination based on tc value

F. Wastewater Analysis

In the analysis of wastewater is needed to find out how much waste water discharge comes out of each house and goes to the drainage channel using the equation (3).

$$Q_{Average} = 5x150x80\% = 600\ L/day \quad (3)$$

And for Q the peak uses equations

$$Q_{top} = 600\ x\ 14{,}4 = 8656.2\ L/day$$

$$Q_{top} = 0.000100\ m^3/sec$$

G. Hydraulic Analysis

- *Drainage Capacity*

After runoff discharge, household discharge and channel discharge are calculated, then evaluated the capacity of the drainage system with the following requirements:

For Loop A point A2-A3 Q Total > Q Channel, 0.0415 m^3/sec > 0.0309 m^3/sec (unable to accommodate)

- *Percentage Difference in Drainage Capacity*

For the percentage of the difference in discharge drainage capacity reviewed is the discharge on drainage that cannot accommodate so that it is calculated the difference between runoff discharge and discharge in the channel to be used as a high addition to drainage then obtained excess water as follows:

For Loop A point A2-A3
ΔQ = Q Channel – Q total
= 0.0309 – 0.0415
= - 0.0106 m^3/sec

Percentage of excess water difference:

$$= \frac{(-0.0106)}{0.0309} x100\% = -34\%$$

No	Loop Name	Point	Q Total (m3/sec)	Q Channel (m3/sec)	ΔQ (m3/sec)	(%)
1	Loop A	A1-A2	0,0018	0,0465	0,0447	96
2		A2-A3	0,0415	0,0309	-0,0106	-34
3	Loop B	B0-B1	0,0015	0,0083	0,0068	82
4		B1-B2	0,0155	0,0813	0,0658	81
5		B2-B3	0,0210	0,0487	0,0277	57
6	Loop C	C0-C1	0,0023	0,0150	0,0128	85
7		C1-C2	0,0161	0,1050	0,0889	85
8		C2-C3	0,0319	0,0625	0,0305	49
9		C0-C3	0,0133	0,0820	0,0687	84
10	Loop D	D0-D2	0,0016	0,0146	0,0130	89

No	Loop Name	Point	Q Total (m3/sec)	Q Channel (m3/sec)	ΔQ (m3/sec)	(%)
11		D2-D3	0,0111	0,0514	0,0403	78
12		D0-D1	0,0104	0,0490	0,0386	79
13	Loop E	E0-E1	0,0015	0,0596	0,0580	97
14		E1-E2	0,0268	0,0642	0,0374	58
15		E3-E4	0,0177	0,0525	0,0348	66
16		E0-E4	0,0069	0,0643	0,0574	89
17	Loop F	F0-F1	0,0016	0,0421	0,0405	96
18		F1-F2	0,0065	0,0651	0,0586	90
19		F2-F3	0,0012	0,0236	0,0224	95
20	Loop G	G0-G1	0,0023	0,0200	0,0177	89

Table 3:- Percentage of drainage capacity difference

H. Discussion

➢ *Drainage Capacity (Table 3)*

After analyzing the calculation of capacity and condition of the drainage system Jl. Bangkala In 5 Makassar City is already unable to drain rainwater discharge so that it pumps into the road. This is due to the drainage that exists today is already inefficient in terms of itsuse. Based on the results of the analysis obtained the highest channel Q is on *Loop* C point C1-C2:0.1050 m^3/ second and Q the problematic channel is on *Loop* A point A2-A3:0.0309 m^3/second. Where the condition of the channel system on *Loop* C point C1-C2 can still drain water discharge while in *Loop* A point A2-A3 is no longer able to drain debir water.

From the results of the above analysis can be concluded that there are several factors that affect drainage capacity, namely:

- Land conditions
- Runoff
- Channel slope
- Channel Shape

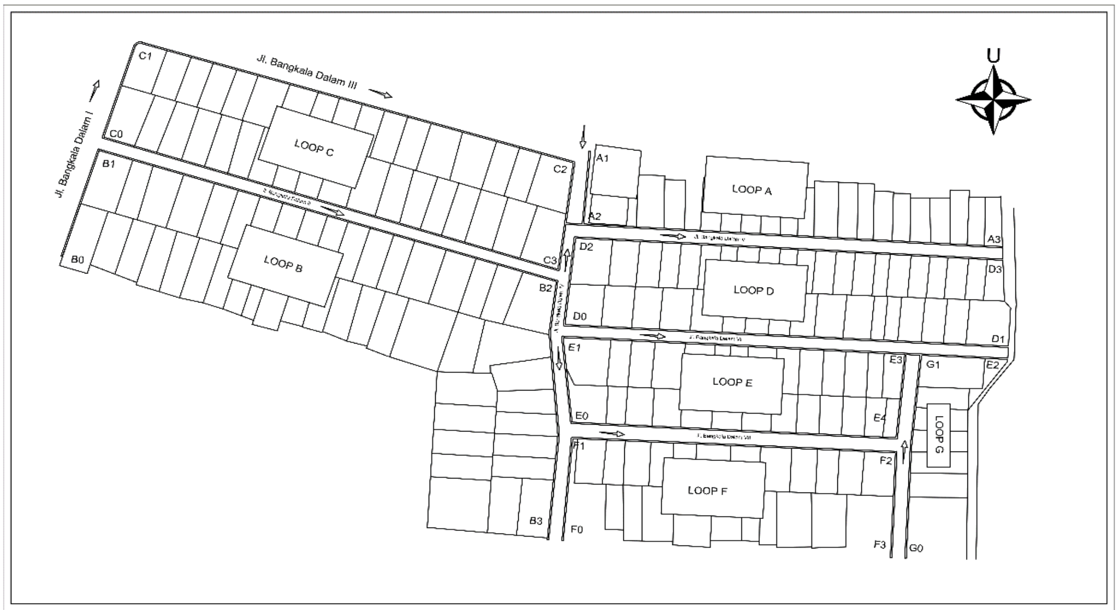

Fig 4:- Drainage network map

To overcome the problems that occur at the study site, namely, Jalan Bangkala In 5 Makassar, there are several solutions that can be done, including water flow that affects the conditions of upstream and downstream boundaries need to be taken into account to analyze drainage capacity, changes in channel dimensions if the surrounding land still allows changes in channel dimensions can also use catchment wells that serve as a place to accommodate falling rainwater so that they are Rainwater runoff does not directly flow into drainage channels.

V. CONCLUSION

From the results of research study of network systems and the capacity of bangkala drainage channels in 5 Makassar, it can be concluded that:

- The effect of surface runoff discharge on the drainage channel discharge is obtained the highest point of excess water or runoff is Loop A point A2-A3 where Q Total 0.0415 m^3/sec > Q Channel 0.0309 m^3/sec = Unable to drain. With excess water that is -0.0106 m^3/sec or 34%. Then the discharge reviewed is the difference between runoff discharge (total) and discharge in the drainage channel then obtained excess water.
- The capacity and condition of the drainage system based on the results of calculations, the existing capacity in the drainage channel on Jl. Bangkala Dalalm 5 Makassar City obtained the highest Q channel, namely Loop C point C1-C2: 0.1050 m^3/sec and Q of the problematic channel, namely on Loop A point A2-A3: 0.0309 m^3/sec. Where the condition of the channel system on Loop C point C1-C2 can still drain water discharge and on Loop A point A2-A3 is no longer able to drain water discharge.

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