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Policy Suitability Among Three Sources of Regulations to Support the Zero Run-Off Concept on The Discharge of The Q 5 Flood in Crowded Area

Bambang Eko Widyanto[1], Sandy Radhitya Akbar[2], Fuad Hasan[3]

Abstract---*Several crowded area in Central Jakarta have a flood problem. The crowded area, less of infiltration area and bad drainage make this condition become worst. Several steps have used by the government, but it does not have a significant impact. An increasing of population linear with the increasing of land use changing. The land use changing from open space area which could infiltrate the rainwater change to housing, village, and another non infiltrated area. The government creates a rule to avoid flood potential which happened almost every year. Some of them are Environmental Minister Rule Number 12 2009 about The Rainfall Utilization, DKI Jakarta's Governor Rule Number 20 2013 about Infiltration Well, and the last one is Indonesian National Standard Number 8456 2017 about Infiltration Well and Infiltration Pit of Rainfall. The three of them cannot be applicated partially, they have to applicated thoroughly. An effort to reduce runoff discharge that caused by heavy rainfall have to be started from around us. From the analysis we got the conclusion that the limit of channel area can be supported by an amount of combination between infiltration well and infiltration pit.*

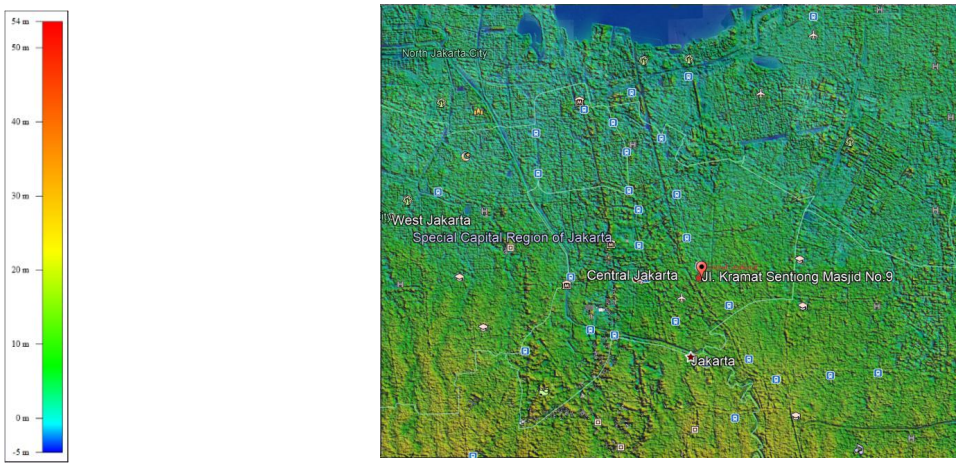
Keywords---*rainfall, drainage, flood, regulation, infiltration well*

I. Introduction

Several crowded area in Central Jakarta have a flood problem. The crowded area, less of infiltration area and bad drainage make this condition become worst. Several steps have used by the government but it doesn't have a significant impact. An increasing of population linear with the increasing of land use changing. The land use changing from open space area which could infiltrate the rain water change to housing, village, and another non infiltrated area. The government creates a rules to avoid flood potential which actually happened almost every year. Some of them are Environmental Minister Rule Number 12 2009 about The Rainfall Utilization, DKI Jakarta's Governor Rule Number 20 2013 about Infiltration Well, and the last one is Indonesian National Standard Number 8456 2017 about Infiltration Well and Infiltration Pit Of Rainfall. The three of them can't be applicated partially, they have to applicated thoroughly. An effort to reduce runoff discharge that caused by heavy rainfall have to be started from around us. For sample in this case the writer use a small area in Kramat Sentiong Street in Central Jakarta. The condition in this area seem so narrow and the

[1]*Civil Engineering Program Study, Faculty of Engineering, Widyatama University Bandung, Indonesia*
bambang.widyanto@widyatama.ac.id
[2]*Civil Engineering Program Study, Faculty of Engineering, Widyatama University Bandung, Indonesia*
sandy.akbar@widyatama.ac.id
[3]*Civil Engineering Program Study, Faculty of Engineering, Widyatama University Bandung, Indonesia*
hasan.fuad@widyatama.ac.id

drainage channel is so small because of the limit of area. An existing channel is around 0.4 m height and 0.4 width or around 0.16 m^2. Another concern about this area is that this area is in a low elevation as can seen in picture below.



Source: DEMNAS

From picture above we can see that the elevation of the area is around 8 msl, and it is lower than area around. The drainage condition in this area is not a good one as we can see in picture below.

Source: Google Street

As we seen in picture above the area doesn't have a proper drainage system. The rainfall water will flooded the area until the rainfall was stopped and the water in area go to small drainage, infiltrate to the soil and evaporated. Another problem in this area is the topography in the elevation profile for long section of Kramat Pulo Buntu street is like a basin as shown the picture below.

Source: Google Earth

The red arrow show the lowest elevation in this area, it show us that the water will pooled this area first and flood area around. The steep of this area is around 1.3 % with 75 m length from the South and 0.65% with 153 length from North. An early drainage system isn't be able to accommodate this condition because of several factors such as :

1. The small drainage in one side of the street

   The drainage channel only available in one side of the street, at the West side. The dimension of channel is around 30 cm to 40 cm.
2. The flushing channel below the Kramat Sentiong Station has been closed.

Blue arrow in picture above was a flushing drain from this area to a bigger channel, existing condition can be seen in picture below.

The red circle is an existing drain outlet from the area, the outlet's drain is in another side of Kramat Sentiong Station. .The condition right now is the channel below the railway was started to collapse and the outlet channel was closed with another building.

To avoid the flood possibility in the area, the three regulations need to be combined to support the drainage system. The three of them are :

II. Methodology

To analyze the flood potential in this area, there ara several steps to do, the steps are:

1. Determine the main line of regulation system of rainfall management
2. Catchment Area Management
3. Rainfall Analysis
4. Discharge analysis

Regulation Management

In order to accommodate the Minister Rules number 12 2009 about The Rainfall Utilization [1], there are several point that have to be agreed, such as :

- Every building owner is mandatory to do the rainfall utilization. (Article no. 3 Verse 1)
- Rainfall Utilization as in verse 1 is done through the made of:
  - Detension Pond
  - Infiltration Well
  - Biopori Hole

In order to strengthening Minister Rule number 12 2009, DKI Jakarta's Governor create the Rule Number 20 2013 about infiltration well [2], the main points about it are:

- The mandatory to create infiltration well is for everyone (Article 3):
  - The owner of building which close the surface
  - Every gorund water user

To make it clearer National Standard of Indonesia create the SNI 8456:2017 about Infiltration Well and Infiltration Pit of Rainfall [3]

- The Formula for Well Depth is shown below:

$$H = \frac{Q}{\omega \pi r K}$$

H : Well Depth (m)
r : well Radius (m)
K : Soil Permeability (m/hour)
Q : Discharge (m^3/hour)
ω : 2 for impermeable wall
ω : 5 for permeable wall

- The Formula for Pit Length is shown below:

$$H = \frac{Q^2}{\beta b H^2 K^2}$$

H : Pit depth (m)
B : Pith Length (m)
b : Pit Width (m)
K : Soil permeability (m/hour)
Q : Discharge (m^3/hour)
β : 16 for impermeable wall
β : 40 for permeable wall

Cathcment Area Management

Catchment area in this area is stand of three sub cathcment area that can be seen ini picture below.

The characteristic for each sub cathcment area can be seen in table below:

Catchment	Catchment (A) Ha	Cr	Surface Slope	Lo (Km)	L (m)
CA1	5.24	0.85	0.00208	0.48	480.00
CA2	1.10	0.85	0.00585	0.17	171.00
CA3	0.56	0.85	0.00962	0.10	104.00

Rainfall Analysis

Based on BMKG the rainfall in Kemayoran Rainfall Station can be seen in table below.

Year	Rainfall (mm)
2008	192.7
2009	122.5
2010	93
2011	119.2
2012	105.2
2013	193.4
2014	147.9

Year	Rainfall (mm)
2015	277.5
2016	124.5
2017	179.7
2018	104.6
2019	90.5
2020	145.3

Based on SNI 2415-2016 about Discharge Design Calculation [4], to determine rainfall design the calculation have to through the frequency analysis. The result of it can be seen in table below :

Periode (Years)	t	Probability Distribution					
		Normal	Lognormal 2 Paramet.	Lognormal 3 Paramet.	Gumbel I	Pearson III	Log Pearson III
2	0.0000	145.8	137.0	136.0	138.4	134.6	133.3
5	0.8416	190.6	184.4	183.0	198.7	183.5	179.8
10	1.2816	213.9	215.4	214.8	238.7	216.4	214.8
20	1.6449	233.2	244.9	245.7	277.1	247.9	251.9
25	1.7507	238.8	254.2	255.5	289.2	257.8	264.4
50	2.0537	254.9	282.9	286.2	326.7	288.2	305.4
100	2.3263	269.4	311.5	317.3	363.9	318.2	350.2
1000	3.0902	310.0	407.9	424.8	486.8	416.3	532.7
Maximum Deviation		15.61	10.72	10.14	11.09	8.80	8.60
Delta Kritis (Sig. Level 5 %)		36.1	36.1	36.1	36.1	36.1	36.1

Based on table above rainfall design will use Log Pearson III distribution.

Discharge Analysis

Discharge analysis for this area is spearated into three area. The formula to determine discharge is :

$$Q = 0.00278\ C\ I\ A$$

C = Run Off Coefficent (0.85)

A = Area (Ha)

I = Rain Intensity

Rainfall intencity that we use is R5 or five years periode rainfall, it suitable with the Q5 or five years discharge.

The calculation for area 1 can be seen below:

C = 0.85

A = 5.24 Ha

Tc = To + Td

To = $(((0.87 \times Lo^2)/(1000*Slope))^{0.385})60$

Td = (1/60) x (L / 0.5)

I = (R/24) x (24/tc)^(2/3)

= $(179.764 / 24) \times (24 / (40.36/60))^{(2/3)}$

= 81.18

Q = 0.00278 C I A

= 0.00278 x 0.85 x 81.18 x 5.24

= 1.01 m3/Sec

The recapitulation for all area can be shown in table below:

Catchment	Catchment (A) Ha	Q (m^3/s)
CA1	5.24	1.01
CA2	1.10	0.45
CA3	0.56	0.33

III. Analysis and Discussion

Based on the data above we can determine how to avoid the flood in that area, the steps are :

1. The need of channel analysis
2. The need of well and pit analysis

The Need Of Channel Analysis

Corelation between discharge and channel area is :

$$Q = V \times A$$

Q = Discharge

V = Velocity

A = Area

Velocity Formula is :

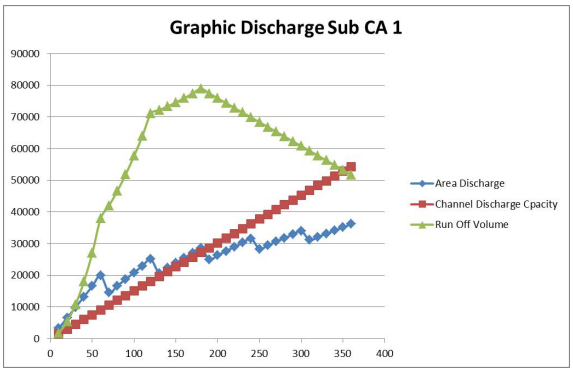
$$V = (1/n)\, R^{(2/3)}\, S^{(1/2)}$$

In order to know how big the channel we need, we devide the Discharge with Velocity. The value of Velocity and minimum area of channel in every sub cathcment can be seen below.

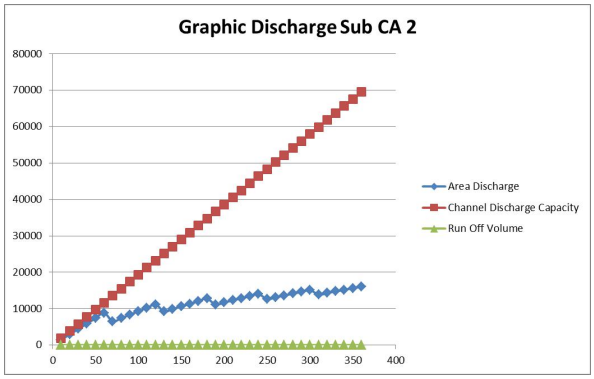
Sub Cathment	Velocity (m)	Discharge (m3/sec)	Height (m)	Width (m)	Minimum Area (m2)
CA1	1.57	1.01	0.90	0.90	0.81
CA2	2.01	0.45	0.60	0.60	0.36
CA3	2.28	0.33	0.50	0.50	0.25

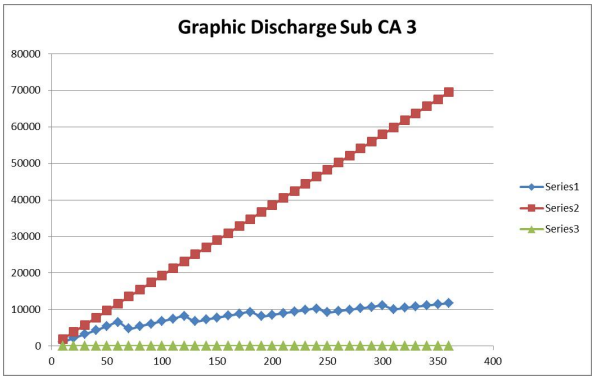
From the result above we can see that all channel are bigger than 0.16 m^2, so it seems the area need more support from infiltration well. The flood volume and height for Sub Catchment 1 are shown below.

Minutes	Discharge (m3/s)	Flood Volume	Height Of Flood (m)
10	3319	1808	0.03
60	19913	37975	0.72
70	14635	42037	0.80
120	25089	71049	1.36
130	20742	72154	1.38
180	28720	78957	1.51
190	25025	77446	1.48
240	31610	69894	1.33
250	28376	68383	1.31
300	34051	60831	1.16
310	31159	59320	1.13
360	36184	51768	0.99



For the same methode, the results for sub catchment 2 and 3 are shown below.





Based on two graphic above, we can make sure that Sub CA 2 and Sub CA 3 don't need the infiltration well.

The Need Of Well And Pit Infiltration Analysis

In order to determine the characteristic of well, the parameter for well infiltration are shown below:

The value of soil permeability based on "Penggunaan Metode Falling Head Dalam Menentukan Daya Serap Air Untuk Mereduksi Genangan Di Kampus FT-UMJ" [5] is around 12 m / day. So the K value is around 0.5 m/hour.

$$H = \frac{Q}{\omega \pi r K}$$

H : Well Depth (m)
r : well Radius 1 (m)
K : Soil Permeability 0.5 (m/hour)
Q : Discharge 3618.44 (m^3/hour)
ω : 2 for impermeable wall

The value of discharge to be accomodated is $Q_{Discharge} - Q_{Channel}$ = 2712.14 m3/hour

$$H = \frac{2714.12}{2x3.14x1x0.5} = \pm 864 \text{ m}$$

In order to make it efficient, the well height is designed for around 2 m so an amount of it is around 432 wells.

IV. Results

The result from the research is that this area have a very small area to used as a drainage channel, the width that could be used for drainage channel just around 0.4 m. To support the drainage system, the area need to build 432 infiltration wells.

V. Conclusion

To avoid flood in Kramat Sentiong area there are so many ways to do, channel normalisation is a must, but use the infiltration well is another thing should do. The amount of infiltration well is around 432 wells with 2 meters deep and t meters height.

REFERENCES

[1] Minister Of Environmental Rules number 12 2009 about The Rainfall Utilization
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