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UTILIZATION OF POROUS INTEGRATION WELL AS AN ALTERNATIVE FOR SURFACE RELEASE CONTROL IN WAREHOUSE COMPLEX

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Abstract — **Bati-Bati Subdistrict is the economic route for Banjar Regency, Tanah Bumbu Regency, and Kotabaru Regency which can be seen by the presence of warehousing buildings. This is one of the causes of land-use changes in Bati-Bati District. Changes in land use resulted in reduced water catchment areas and increased surface water runoff. So that in planning the warehousing area it is necessary to plan infiltration wells that function to reduce surface runoff and absorb water into the ground. This study aims to analyze the design of infiltration wells in a warehouse complex as an alternative to reduce surface runoff. The dimensional analysis of porous infiltration wells refers to the planning procedures for rainwater infiltration wells regulated in SNI 8456: 2017. From the calculation results, it is found that porous-walled wells with a depth of 3 m total 21 wells with a diameter (D) = 0.8 m, 17 wells with D = 1 m, and 12 wells with D = 1.4 m.**

Keywords — **Warehousing area, infiltration wells, rainfall, Bati-Bati Kecamatan District**

I. INTRODUCTION

The government is increasingly raising service standards for the welfare of people's lives, this causes an increase in development infrastructure resulting in changes in land use. Changes in land use will result in a reduced open land as rainwater catchment areas if the land use is not planned properly. Infiltration wells are places that function to reduce runoff or collect rainwater and help absorb water into the ground. (Isramaulana, 2014)

Bati-Bati District is a location that borders the City of Banjarbaru and the road in Bati-Bati District is a route for economic flows to Banjar Regency, Tanah Spice Regency, and Kotabaru Regency. Based on this, Bati-Bati Sub-district is one of the sub-districts that has improved infrastructure development in the industrial sector. The industrial sector infrastructure that is mostly built is warehoused because warehouses are important infrastructure in meeting the availability and increasing the industrial sector.

With the increasing number of warehouse construction, there will be an increase in surface water runoff so in this study the use of porous infiltrationwells as an alternative to control surface runoff in warehousing complexes.

II. LITERATURE REVIEW

The following are some previous studies: Research I - (Widhi, 2017) this research is entitled "Analysis of Infiltration Well Needs in the Context of Water Conservation at the University of Muhamadiyah Sukarta Campus". This study aims to determine thenumber of needs and dimensions of effective absorption wells. The location for the research study is Campus II, Muhammadiyah University, Surakarta. In this study, rainfall analysis only uses one climatological station in less than 10 years. After analyzing the frequency, the method used for the design rain analysis is the Pearson log distribution type
III. Infiltration well planning is based on a 25 year return period discharge analysis where 8 infiltration wells are obtained with a radius of 0.5-1 m with a depth of 0.36-2.56 m.

Research II- (Chairil Fachrurazie, Yulian Firman Arifin, & Dewi Sri Susanti, 2012) this research is entitled "Analysis of Infiltration Well Drainage at the ULM Banjarbaru Campus". This study aims to determine the dimensions of infiltration wells that are environmentally sound. The location for the research study is UNLAM Banjarbaru Campus. In this study, the design rainfall analysis used the Gumbel method and the log person method type III where the results for the Gumbel method were 130.20 mm for a 5 year return period and the log Pearson type III method obtained a design rainfall of 125.05 mm. Rainfall intensity is planned with a return period of 5 years and the rainfall intensity is 45.14 mm/hour. Infiltration wellplanning is planned in 2 formulas, namely: (1) For impermeable walls there are 4 wells in the Faculty of Engineering building with a depth of 5.5 m, the Facultyof Forestry building obtained 3 wells with a depth of 5.5 m, and in the Faculty of Fisheries building obtained as many as 3 wells with a depth of 5.5 m; (2) For porous walls, there are 4 wells in the Faculty of Engineering building, 3 wells in the Faculty of Forestry building with a depth of 4.5 and the Faculty of Fisheries building there are 3 wells with a depth of 4.5 m.

Research III- (Lussiany Bahunta and Roh Santoso Budi Waspodo, 2019) this research is entitled "Design of Rainwater Infiltration Wells as a Means of Efforts to Reduce Runoff in Babakan Village, Cibinong, Bogor Regency". This study aims to determine how many infiltration wells are needed. This research is located in Babakan Village, Cibinong, Bogor Regency, and was carried out in 2019. This study uses maximum daily rainfall data for the last 10 years and in infiltration, well planning uses SNI 03-2453-2002. The method used in the design rainfall analysis is the log Pearson type III method with the planned rainfall value in the 2-year return period of 97.36 mm/day. Soil permeability after researching at 5 points obtained a value of 3.48 cm/hour. So that a total of 115 infiltration wells were obtained with different depths according to the roof area in the research area.

Research IV- (Maya Amalia, & Aulia Hidayati, 2020) this research is entitled "Infiltration Wells in Warehousing Complexes as One Form of Drainage System". This study aims to analyze the dimensions of infiltration wells to apply the concept of a sustainable drainage system. This research is located in the warehousing area of Tanah Laut Regency, Bati-Bati District. This study only used rainfall data obtained from the sub-district. The method used in the design rainfall analysis is the log Pearson type III methodwhere 107 wells are obtained with a diameter of 1 m and a depth of 4 m.

A. *Hydrological Analysis*

The dominant hydrological element in an area is rainfall, therefore rainfall data for an area applies the main data in determining the magnitude of the planned flood discharge and the mainstay discharge that occurs in the area.

1) *Regional Rainfall Analysis*

The hydrological analysis is needed as an analysis in determining the amount of the design discharge in a water structure design such as infiltration wells. the rain analysis plan requires rainfall data, namely the maximum rainfall. Because around the research location, there are 2 rain stations, it is calculated first. In this study, the analysis of regional rainfall uses the algebraic method because this method is more objective than the isohyet method. The algebraic method is a method of calculating the average rainfall around the area concerned. (Chandrawidjaja, 2010)

The algebraic method is formulated by:

$$\bar{R} = \frac{1}{n}(R_1 + R \qquad) \qquad (1)$$

Where:

$\bar{R}$ = rainfall area (mm)

N = number of observation points

R_n = rainfall at each observation point (mm)

2) *Frequency Analysis*

The usual hydrological analysis calculations use the normal distribution, log-normal distribution, Pearson type III log distribution, and Gumbel distribution (Suripin, 2004).

3) *Distribution Conformity Test*

The distribution suitability test consisted of the chi-square test and the Smirnov-Kolmogorov test.

4) *Design Rainfall Analysis*

The distributions commonly used in the analysis are Normal distribution, log-normal distribution, Gumbel distribution, and log-normal distribution:

- Normal Distribution

  The normal distribution equation is formulated as follows (suripin, 2004):

$$X_T = X + K_T \cdot S_d \qquad (2)$$

dengan:

X_T= design rainfall

X = average value

S_d = standard deviation

K_T = frequency factor

- Normal Log Distribution

  From the above formula obtained:

$$X_T = b + \frac{1}{a} Y.\mathrm{N} \qquad (3)$$

with:

X_T = design rainfall

Y_T = *reduced varied*

- Pearson Type III Log Method

  Calculation of the Pearson log method is formulated by:

  Average rainfall

$$\text{Log x} = \frac{\sum_{t=1}^{n}(\log xi - log xi)^2}{(n-1)} \qquad (4)$$

Standard deviation

$$\delta \log xi = \sqrt{\frac{\sum_{t=1}^{n}(log\, xi - log xi)^2}{(n-1)}} \qquad (5)$$

Stiffness coefficient

$$\text{Cs} = \sum^{n} \quad (\log xi - log xi)^2 \qquad (6)$$

necessary to know the regional rainfall

$$\frac{t=1}{(n-1)(n-1).S_i^3}$$

Pearson's log equation type III

$$\text{Log } X_T = \log x + (\text{KTR}.S_i) \qquad (7)$$

with :

Log X_T = logarithm of water discharge

KTR = *skewness value*

log xi = standard deviation

A. Rainfall Intensity

Intensity is the amount of rain expressed in height of rain in unit time. To calculate the intensity of rainfall, use the rational formula according to Dr. Mononobe *(SNI 8456: 2017)*

$$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{2/3} \qquad (8)$$

where:

I = rainfall intensity (m/hour)

R_{24} = Planned rainfall

t = duration of rainfall / duration of rainfall (hours)

1) Rain Duration
Total runoff from rain is directly related to the duration of rain with a certain intensity. Each watershed has one critical rain duration.

2) Rainfall Distribution
In general, the maximum runoff rate and volume will occur if the entire watershed has contributed to theflow.

3) Flow Coefficient (C) Land Use
The flow coefficient (C) of land use can be seen in table 1.

Table 1. Flow Coefficient (C) Land Use

No	Land Description	Surface Character	C
1	Business	Urban	070 - 0,90
		Periphery	0,5 - 0,70
2	Housing area	Residential home	0,30 - 0,50
		Multiunit, separate	0,40 - 0,60
		Multiunit, merged	0,60 - 0,75
		Village	0,25 - 0,40
		Apartment	0,50 - 0,70
3	Industry	Light	0,50 - 0,80
		Heavy	0,60 - 0,90
4	Pavement	Asphalt and concrete	0,70 - 0,95
		Brick, Paving	0,50 - 0,70
5	Roof		0,75 - 0,95
6	Courtyard, sandy ground	Flat 2%	0,05 - 0,10
		Average, 2-7%	0,10 - 0,15
		Steep 7%	0,15 - 0,20

Source : (Suripin, 2004)

C . Porous Infiltration Well

Generally, these porous wells are used in water catchment areas in cultivation areas, offices, industries, shops, settlements, and other facilities. An example of an infiltration well with a porous wall can be seen in Figure 1.

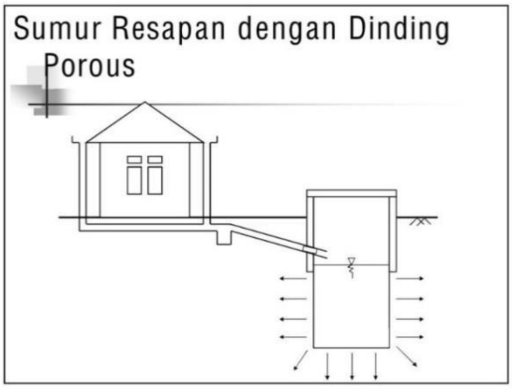

Figure 1. Porous Wall Infiltration Well

Source : (Novitasari, 2012)

1) Uses of Porous Infiltration Wells
   - Conservation or Preservation of Groundwater
   - Erosion Rate Suppression
   - Increase in Water Reserves and Groundwater Level
   - Flood Prevention and Control
   - Groundwater barrier

2) Factors Affecting Infiltration Well Dimensions
Planning the dimensions of infiltration wells on land is influenced by several factors, namely (Suripin, 2004) :
   - Closing surface area
   - Rain characteristics, including the intensity of rain, duration of rain, and the interval of rain.
   - Soil permeability.

Table 2. Soil Permeability Value

No	Soil Permeability	Mark	
1	Currently	2,0 – 3,6	0,48 - 0,864
2	Kinda fast	3,6-36	0,865 - 8,64
3	Fast	>36	> 8,64

Source : (SNI 8456 : 2017)

- Ground water level

The formula for porous infiltration wells can be seen in the following equation:

$$H = \frac{Q}{\omega \pi D K} \qquad (10)$$

Price ω = 5

with:

H = depth of well (m)

D = diameter of the well (m)

K = soil permeability coefficient (m/hour)
Q = runoff discharge (Q = C.I.A) (m^3/hour)

where:
Q = runoff discharge (m^3/ hour)
C = runoff coefficient (0,70)
I = rain intensity (mm/hour)
A = area (m^2)

C. Research Stages

This research will be conducted in one of the warehousing complexes in the Bati-Bati District, Tanah Laut Regency

This study uses secondary data in the form of rainfall data, land conditions, soil permeability, and soil depth obtained from BMKG around the research location and previous studies. The research stage begins with an analysis of regional rainfall using the algebraic method, the design rainfall distribution using the Pearson type III log method. The analysis of runoff discharge uses a rational method, and the dimensional analysis of infiltration wells refers to the planning procedures for rainwater infiltration wells as regulated in (SNI 8456 : 2017)

III. RESULTS AND DISCUSSION

A. Hydrological Analysis

1) Regional Rainfall Analysis

Calculation of regional rainfall using the algebraic method can be seen in table 3.

Table 3. Regional Rainfall

Year	Regional Rainfall (mm)
2001	69,40
2002	59,90
2003	139,65
2004	136,00
2005	34,70
2006	68,90
2007	59,15
2008	73,90
2009	76,00
2011	108,70
2012	64,05
2014	151,80
2017	83,20
2018	93,80
2019	79,25
2020	104,50

Source: Calculation

2) Frequency Analysis

The results of the analysis of the distribution selection can be seen in table 4.

Table 4. Distribution Selection

No	Distribution	Syarat	Analysis Results	Description
1	Normal	Cs = 0	4,99	No
2	Normal log	CS/CV = 3	1,3	No
3	Gumbel	CS = 1,1396	4,99	No
		CK = 5,4002	2,1	No

Source: Calculation

After the analysis, the values of CC, CV, and CKdo not meet the requirements of the normaldistribution method, normal log distribution, and Gumbel distribution so the distribution method usedin the design rainfall analysis is the log Pearsontype III method. In some studies, the log Pearson type III method is used in the design rain analysis.

3) Design Rainfall Analysis (CHR)

The value of CS = -0.26 is obtained, so that the design rainfall for the 2-year return period using the Pearson log type III is:

CHR = log (log mean + KTR* S)
= log (1,91 + 0,045*0,16)
= 84,54 mm

B) Rainfall Intensity

Calculate the intensity of rainfall using the Mononobe formula. Based on (SNI 8456: 2017)the duration of rainfall/rain duration used in planning is 2 hours and the return period is 2 years. The design rainfall value for the 2-year return period is 83.54 mm, so the rainfall intensity value is:

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

$$I = \frac{83,54}{24}\left(\frac{24}{2}\right)^{2/3}$$

= 18, 2154 mm/hour or 0,018215 m/hour

C) Runoff Discharge

The discharge used for the design of infiltrationwells according to the procedures for planning rainwater infiltration wells refers to (SNI 8456: 2017). The runoff discharge formula uses the rational method. Thefollowing is the calculation of runoff from the warehousing area of Bati-bati District, Tanah Laut Regency with a return period of 2 years:

- Empty land

  Q = 0,4*0,018215*20555
  = 146,79 m^3/hour

- Paving area
  Q = 0,7*0,018215*5218
  = 66,53 m^3/hour
- Building area
  Q = 0,95*0,018215*12187
  = 210,88 m^3/hour
  Concrete cast area
  Q = 0,7*0,018215*19617
  = 250,12 m^3/hour

D) Calculation of Porous Infiltration Well

Calculation of the depth of infiltration wells refers to the planning procedures for rainwater infiltration wells which are regulated in (SNI 8456: 2017). Based on previous research, it is known that the research location is moderate soil permeability so in this study the soil permeability value is assumed to be 0.865 m^3/m^2/day. It is planned that infiltration wells with porous walls with a depth of 3 m with different good diameters where the diameter can later beadjusted to the conditions in the field when making infiltration wells.
Example of calculating a porous walled well with a diameter of vacant land

- Empty land
  H $= \frac{149,76}{5*3,14*1,4*0,865}$
  = 7,88 m
  Then obtained 3 porous wells with a depth of 3 m
- Paving area
  H $= \frac{66,53}{5*3,14*1,4*0,865}$
  = 3,5 m
  Then obtained 1 porous well with a depth of 3 m
- Building area
  H $= \frac{210,881}{5*3,14*1,4*0,865}$
  = 11,09 m
  Then we get 4 porous wells with a depth of 3 m
- Concrete cast Area
  H $= \frac{250,12}{5*3,14*1,4*0,865}$
  = 13,16 m
  we get 4 porous wells with a depth of 3 m

The recapitulation of the number of porous infiltration wells D = 0.8 m, 1 m, 1.4 m with h = 3 m can be seen in table 5.

Table 5. Recapitulation of the number of porous wells with diameters of 0.8 m, 1 m, 1.4 m

Land Type	Number of Wells		
	D = 0,8 m; H = 3 m	D = 1 m; H = 3 m	D = 1,4 m; H = 3 m
Empty land	5	4	3
Paving	2	2	1
Building	6	5	4
Cast Concrete	8	6	4
Total	21	17	12

Source: Calculation

IV. CONCLUSIONS AND SUGGESTIONS

1) Conclusion

- Calculation of the design rainfall using the log Pearson type III method which obtained rainfall of 83.54 mm in a 2 year return period and 113.41 mm in a 5 year return period.
- The runoff discharge for each land is different where the vacant land with an area of 20.555 m^2 gets a runoff discharge of 149,76 $m^3/hour$, thepaving area with an area of 5.215 m^2 obtains a runoff discharge of 66,53 m^3 /*hour*, the building area with an area of 12.187 m^2 obtains a runoff discharge of 210,88 m^3 /*hour*, the cast area Concrete with an area of 19.617 m^2 the runoff discharge is 250,12 m^3 /*hour*. So that the total runoff discharge in one of the warehousing complexes in Bati-Bati District, Tanah Laut Regency is obtained with a total land area of 57.577 m^2 which is 667,29 $m^3/hour$.
- It is planned that infiltration wells with porous walls with a depth of 3 m and different diameters of 0.8 m, 1 m, and 1.4 m. From the calculation results obtained porous wall wells with a total of 21 wells with the diameter (D) = 0.8 m, 17 wells with the diameter (D) = 1 m, and 12 wells with the diameter (D) = 1.4 m

2) Suggestion

- Porous infiltration wells can be an alternative to reduce surface runoff so that the warehousing area canbuild infiltration wells.
- The dimensions of the infiltration wells are usually adjusted to the capabilities of the existing land in field conditions or the dimensions of the wells available in the field.
- It is recommended for further researchers to prepare knowledge and prepare data carefully so that they are not constrained when conducting research.

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