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REDESIGN OF RESIDENTIAL DRAINAGE SYSTEM IN BEKASI CITY

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Abstract
Margahayu Housing, located in Bekasi City, is one of the flood-prone residential areas that frequently experiences inundation during the rainy season, disrupting residents' daily activities. This study aims to determine the design flood discharge and redesign the drainage channel dimensions to accommodate runoff effectively. The research was conducted through several stages involving primary and secondary data collection, hydrological and hydraulic analyses, and hydraulic modeling using the HEC-RAS software. The hydrological analysis applied the Log Pearson Type III method to determine rainfall distribution, while the Rational Method was used to calculate the design flood discharge based on rainfall data from three stations: Halim, Teluk Pucung, and Bendung Cikarang. The calculated design discharge values were: S1 = 0.376 m^3/s, S2 = 1.147 m^3/s, S3 = 1.124 m^3/s, S4 = 0.273 m^3/s, S5 = 0.430 m^3/s, and S6 = 0.336 m^3/s. The comparison between the existing flow capacity (Qcap) and the design discharge (Qs) indicated that several drainage channels were inadequate to accommodate flood flow. Therefore, a redesign was performed by enlarging the channel cross-sections. The proposed new dimensions for channels S1, S2, S3, and S6 are 1.4 meters in height and 1.2 meters in base width. Validation through HEC-RAS modeling confirmed that the redesigned channels can safely convey the design flood discharge. This study demonstrates that appropriate hydrological and hydraulic modeling plays a crucial role in effective flood mitigation planning for urban drainage systems.
Keywords: Drainage Channel, Flood, Redesign, Hec-Ras

INTRODUCTION

Drainage is one of the basic facilities designed as a water disposal system to meet community needs and serves as an essential component in urban planning, particularly in infrastructure planning. The term "drainage" refers to the process of channeling, draining, removing, or directing water flow. The role of drainage channels is highly important in conveying surface runoff from surrounding buildings and roads. Drainage systems also play a crucial role in flood prevention and mitigation, which often occur during the rainy season.

Flooding is a condition where water cannot be contained within drainage channels (such as riverbeds) or when water flow in drainage systems is obstructed, causing overflow that inundates surrounding areas. This situation is typically caused by high rainfall and topographical conditions characterized by low-lying or concave areas. In addition, floods

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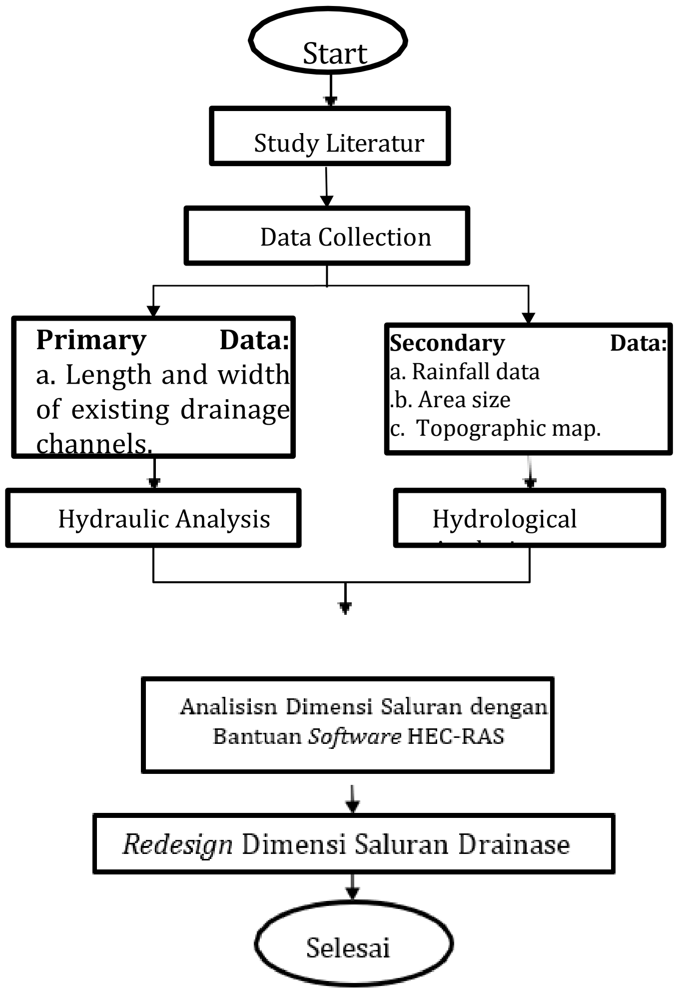
can also occur due to excessive surface runoff volume that exceeds the drainage or river system capacity.

Margahayu Housing Complex in Bekasi City is one of the flood-prone areas in the city, especially during the rainy season, which disrupts community activities to this day. Flood events in Margahayu Housing have been recorded over the years as follows: in January 2013, flood height reached 70 cm; January 2014, around 70 cm; February 2015, 60 cm on the roads; February 2016, 1.5 m; February 2017, between 1.2 m and 2.0 m; February 2018, between 20 cm and 40 cm; May 2019, 1.5 m; February 2020, between 60 cm and 100 cm; February 2021, 1.5 m; and May 2021, between 20 cm and 30 cm. The area affected by flooding ranged from 100,000 m² to 200,000 m².

Therefore, the planning of an effective drainage system in Margahayu Housing, Bekasi City, requires special attention to prevent future flooding or water stagnation, as well as to support a comfortable, safe, and healthy living environment for the residents.

IMPLEMENTATION METHOD

This research was conducted in several stages, and the research method involved the collection of primary and secondary data, hydrological analysis, hydraulic analysis, and modeling using the HEC-RAS software.



The required data consisted of primary and secondary data. The primary data included existing drainage data such as channel width and channel depth, while the secondary data included hydrological analysis data such as rainfall data from rain gauge stations and the total area of Margahayu Housing Complex in Bekasi City, which is approximately 330,000 m^2.

Hydrological Analysis

The hydrological analysis aimed to determine the design flood discharge based on rainfall and return periods.

Rainfall Frequency Distribution: Used to predict possible rainfall magnitudes. The tested distribution methods included:

1. **Normal Distribution:** Calculation of the mean and standard deviation of annual maximum rainfall data.
2. **Gumbel Distribution:** Calculation using Reduced Mean (Yn) and Reduced Standard Deviation (Sn).
3. **Log-Normal Distribution:** Calculation using the logarithm of rainfall data.
4. **Log Pearson Type III Distribution:** Calculation using logarithmic rainfall data and skewness coefficient (Cs).

Distribution Type Determination: The skewness coefficient (Cs) and kurtosis coefficient (Ck) were calculated for each distribution. Based on the frequency distribution characteristics, only the Log Pearson Type III distribution met the distribution requirements (Cs > 0 and Ck within acceptable limits).

Goodness-of-Fit Tests:

1. **Chi-Square Test:** To verify whether the selected distribution represents the sample data. The results showed that Log-Normal and Log Pearson Type III distributions were acceptable, while Normal and Gumbel were not.
2. **Smirnov-Kolmogorov Test:** To test whether the sample originated from a specific distribution population. The results showed that all distributions (Normal, Gumbel, Log-Normal, and Log Pearson Type III) were acceptable.

Test Conclusion: Based on the comprehensive analysis, the Log Pearson Type III method was selected because it satisfied all distribution, Chi-Square, and Smirnov-Kolmogorov test criteria.

Design Rainfall Measurement: The design rainfall was calculated using the Log Pearson Type III method for various return periods (2, 5, 10, 20, 50, and 100 years). For the design flood discharge calculation, a 5-year return period was used, in accordance with Bekasi City's classification as a metropolitan area with a watershed area of 10–100 hectares.

Runoff Coefficient (C): Determined based on land use in the study area (residential zones, asphalt roads, open land). The weighted average value of C was 0.564.

Rainfall Intensity (I): Calculated using the Mononobe formula, assuming the rainfall duration equals the time of concentration. The time of concentration (Tc) was determined based on the channel length and land slope.

Design Flood Discharge (Qs): Calculated using the Rational Method ($Qs = 0.278 \times C \times I \times A$). The Qs values were determined for each drainage channel (S1–S6).

Hydraulic Analysis

The hydraulic analysis aimed to evaluate the capacity of existing drainage channels and redesign their dimensions to accommodate the design flood discharge.

Existing Cross-Section Analysis using the Passing Capacity Method: Flow capacity (Qcap) was calculated for each existing channel. The comparison between Qcap and Qs showed that channels S1, S2, S3, S5, and S6 could not accommodate the design flood discharge (overflow occurred), while S4 remained safe.

Existing Channel Analysis (HEC-RAS): Modeling using HEC-RAS was conducted to visualize the condition of the existing drainage system. The modeling results confirmed that channels S1, S2, S3, and S5 experienced overflow (the water surface exceeded the channel walls).

Drainage Channel Redesign: The selected channel cross-section was an open rectangular type made of precast concrete, which is efficient for land use in densely populated residential areas. New dimensions were calculated for the overflowing channels (S1, S2, S3, and S5), while S4 and S6, which were already safe, remained unchanged. The proposed new dimensions for S1, S2, S3, and S5 were: Height (H) = 1.4 m and Width (B) = 1.2 m.

Redesigned Drainage Channel Modeling (HEC-RAS): Re-modeling with HEC-RAS using the new channel dimensions showed that with the updated size (1.4 m × 1.2 m), channels S1, S2, S3, and S5 were able to accommodate the design flood discharge without overflow.

RESULTS AND DISCUSSION

The calculation of the design flood discharge was carried out using the Rational Method with rainfall data from three stations: Halim, Teluk Pucung, and Bendung Cikarang. The rainfall data used were the maximum daily values from the past ten years. The calculation results showed that the design flood discharge (Qs) for each channel is as follows:

a. Channel S1: 0.376 m^3/s
b. Channel S2: 1.147 m^3/s
c. Channel S3: 1.124 m^3/s
d. Channel S4: 0.273 m^3/s
e. Channel S5: 0.430 m^3/s
f. Channel S6: 0.336 m^3/s

Table 1. Debit banjir rencana

Channel name	A	C	I	Qs
S1	0,011	0,556	220,992	0,376
S2	0,030	0,534	257,389	1,147
S3	0,042	0,452	212,985	1,124
S4	0,008	0,567	216,574	0,273
S5	0,015	0,452	228,057	0,430
S6	0,010	0,462	261,888	0,336

Existing Channel Analysis

The existing drainage channels were found to be incapable of accommodating the design flood discharge, based on a comparison between the existing flow capacity (Qcap) and the design discharge (Qs).

a. This was the main reason for redesigning the channel dimensions.

Drainage Channel Redesign

Based on the comparison between Qcap and Qs, as well as modeling results using HEC-RAS, the following redesign of channel dimensions was proposed: Channels S1, S2, S3, and S6 were recommended to have the following cross-sectional dimensions:

b. Height (h) = 1.4 meters
c. Bottom width (b) = 1.2 meters These dimensions were verified through hydraulic modeling and were proven to effectively accommodate the expected flood discharge.

The Margahayu Housing Complex has experienced recurrent flooding over the years, indicating problems within the existing drainage system. Through hydrological and hydraulic analyses, it was determined that:

1. The main causes of flooding are a combination of high rainfall, insufficient channel capacity, and lowland topography.
2. Rainfall data from the three stations showed extreme values in recent years, indicating an increased flood risk.

The channel capacity analysis revealed that the existing dimensions do not correspond to the design flood discharge. Therefore, a redesign was conducted using a technical approach validated through numerical modeling. The use of HEC-RAS was an important step in aligning the design with actual field conditions more realistically. With the implementation of the validated new channel design, the risk of flooding can be reduced, while residents' comfort and safety can be improved. This demonstrates that proper drainage system modeling and design are crucial aspects in managing flood-prone areas.

CONCLUSION

The design flood discharge calculated for the channels in the Margahayu Housing Complex area are as follows: S1 = 0.376 m^3/s, S2 = 1.147 m^3/s, S3 = 1.124 m^3/s, S4 = 0.273 m^3/s, S5 = 0.430 m^3/s, and S6 = 0.336 m^3/s. Based on the comparison between flow capacity (Qcap) and the design flood discharge (Qs), the existing drainage channels were unable to accommodate the expected flood discharges. This was the main reason for the redesign of the drainage system. The redesign involved enlarging the channel cross-sectional dimensions. The new dimensions for channels S1, S2, S3, and S6 are: Height (h) = 1.4 meters and Bottom width (b) = 1.2 meters. These redesigned dimensions were proven through simulation and calculation to safely accommodate the design flood discharge.

REFERENCES

Aditya, B. (n.d.). Review Desain Sistem Drainase Kelurahan Jaka Mulya, Kota Bekasi. Skripsi, Universitas Diponegoro. Available: https://eprints2.undip.ac.id/12316/1/Repository_Brama Aditya.pdf

DetikNews. (n.d.). Laporan Kejadian Banjir Kota Bekasi. Available: https://news.detik.com

Earth, G. (n.d.). Citra Lokasi Perumahan Margahayu Kota Bekasi. Available: https://earth.google.com

Harijadi. (2015). Pemodelan Hidraulika Menggunakan HEC-RAS. Yogyakarta: UGM Press.

MetroTempo. (n.d.). Banjir Melanda Perumahan Margahayu Bekasi. Available: https://metro.tempo.co

Rusardi, O. F. A. (n.d.). Perancangan Dimensi Saluran Drainase Melalui Metode Rasional (Studi Kasus Drainase di Kota Bekasi). JENIUS, 2(2). Available: https://download.garuda.kemdikbud.go.id/article.php?article=2393790

Soemarto, D. C. (1987). Hidrologi Teknik. Erlangga.

Soewarno. (1995). Hidrologi: Aplikasi Metode Statistik untuk Analisis Data Hidrologi Jilid I. Bandung: Nova.

Suhardjono. (1984). Hidrologi Terapan. Erlangga.

Suripin. (2004). Sistem Drainase Perkotaan yang Berkelanjutan. Yogyakarta: Andi Offset.

T. F. and Darmadi. (n.d.). Perencanaan Saluran Drainase Perumahan Familia Urban Cluster Amethyst, Kota Bekasi. Jurnal Teknik Sipil Arsitektur, 23(2). Available: https://jurnalftspjayabaya.ac.id/index.php/jsa/article/view/198

U.S. Army Corps of Engineers. (2016). HEC-RAS River Analysis System – User's Manual Version 5.0. Hydrologic Engineering Center (HEC), Davis, CA.

Viva.co.id. (n.d.). Banjir di Kota Bekasi Melumpuhkan Aktivitas Warga. Available: https://www.viva.co.id