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PLANNING OF RAINWATER INFILTRATION WELLS BASED ON FIELD PERMEABILITY TEST RESULTS AT SUNAN GIRI UNIVERSITY, SURABAYA

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ABSTRACT

High rainfall intensity combined with low water absorption can lead to flooding and even disasters like urban floods. Sunan Giri University Surabaya (UNSURI) is one of the educational facilities in Surabaya city, specifically located on Brigjen Katamso Street, Waru District, Sidoarjo. One way to reduce or prevent flooding is by planning the construction of rainwater infiltration wells on the ground surface designed to capture rainwater, allowing it to seep into the soil. The system used in this planning is a field permeability test, where permeability is the soil's ability to allow water to pass through, influenced by its porosity and the stability of its aggregates. The objective of this research is to understand how to conduct a permeability test in the field and determine the number of infiltration wells to be constructed within Sunan Giri University Surabaya. The research results provided data for planning the construction of approximately two infiltration well locations.

Keywords: rainfall, permeability test, infiltration wells.

Introduction

Soil is a mixture of minerals, organic materials, and relatively loose deposits located above the bedrock. The formation of soil through physical processes breaks down rocks into small particles due to influences such as water, wind, erosion, ice, human activities, or the breakdown of soil particles caused by changes in temperature and weather (Rifai et al., 2015).

Rainwater is a vital water resource for human and other living organisms. However, with the increasing human population, there's a rise in surfaces covered by concrete and asphalt, making it challenging for rainwater to seep into the ground (Kusnaedi, 1995; Tumpu, 2021). This research aims to analyze rainwater infiltration permeability in various types of urban soils. The method used measures the rate of water infiltration using a double ring infiltrometer on three soil types: clay soil, loamy soil, and sandy soil. The research results indicate that the highest rainwater infiltration permeability is in sandy soil, while the lowest is in clay soil. The permeability of loamy soil lies between sandy and clay soils. The implication of this research underscores the importance of preserving soil functions as a natural resource that influences water quality and maintains ecosystem balance in urban areas. The purpose of this research is to understand how to conduct a permeability test in the field and determine the number of infiltration wells to be constructed.

Permeability refers to the soil's ability to allow water to pass through. Soil permeability is influenced by its porosity and the stability of its aggregates. The more water that enters the soil, the greater the volume of water present, meeting the water needs of plants and making the soil moist (Kusumawardi, 2015).

The development of environmentally conscious drainage systems (SDBL) corrects inefficient rainwater management, which often lacks control and overlooks water conservation goals. Through the construction of SDBL, runoff from upstream areas is temporarily detained, allowing as much water as possible to infiltrate the soil. This is intended to ensure effective groundwater conservation, and the design dimensions of drainage structures can be more efficient.

Research Methods

The method employed in this research is a combination method, utilizing both qualitative and quantitative approaches. This method utilizes data from observations, permeability tests, and the collection of data regarding the research object and hypothesis. The sampling technique for this study uses cluster sampling, specifically focusing on areas around Sunan Giri University Surabaya that are prone to flooding or water accumulation during heavy rain. The data collection technique for this research involves observing the research object along with several other influential variables, such as rainfall intensity and the study area.

The data collection for this research is conducted by counting and observing, as well as documenting the research object. This includes identifying areas that are inundated after rainfall and conducting field permeability tests. With the data analysis carried out, it is hoped that it will serve as a complementary aspect to this study.

Results and Discussion

From surveys and interviews, it can be determined that the reason for the flooding at UNSURI Surabaya is not due to the lack of drainage or channels, insufficient open space, or university policies. There might be other factors contributing to the emergence of this water accumulation, such as high rainfall and low water absorption rates. The runoff rate at the UNSURI Surabaya location is indicated in the table:

Table 1. Total Runoff in the UNSURI Surabaya Area

Number	Location	Location Area (m^2)	Runoff Rate (m^3/hour)
1	In front of the Faculty of Engineering laboratory	9249,3	172,792
Total runoff for the entire UNSURI Surabaya area		41305,0	771,643

Based on the data in the table, the total runoff across the entire area of Sunan Giri University Surabaya is 771,643 m^3/hour or 0.214 m^3/s. For the open area located in front of the engineering faculty laboratory, the runoff value is 172,792 m^3/hour or 0.048 m^3/s.

Considering the canal volume data of 388,194 m^3, a canal flow rate of 7,812 m^3/hour, and the total runoff from UNSURI at 771,643 m^3/hour, and in front of the laboratory at 172,792 m^3/hour, it can be concluded that the existing drainage system at UNSURI should be capable of handling water flow normally. However, this also depends on the flow rate of the river at the canal outlet. When the river flow rate rises above the normal limit, water can reverse its direction towards the canal. Given a canal capacity of 388,194 m^3 and a flow rate of 2.17 m^3/s, it would take only 178 seconds or 3 minutes and 18 seconds to fill it up. Based on these considerations, rainwater infiltration wells are needed either as a buffer or to reduce the volume of water entering the drainage system.

Table 2. Results of Infiltration Tests

Number	Location	Decrease	Volume (m^3)	Time Required (minute)	Filtration Rate (m^3/hour)
1	Point A	20 cm	0,0035325	21	0,01009
2	Point B	20 cm	0,0035325	20	0,01060
3	Point C	20 cm	0,0035325	20	0,01060

4	Point D	20 cm	0,0035325	19	0,01116

Based on the initial research objective of reducing runoff, the design of infiltration wells can be considered effective in reducing total runoff. Although not all runoff can be absorbed into the ground, these infiltration structures increase the retention time of water, allowing it to seep into the soil. Moreover, implementing this concept has successfully reduced more than 50% of the total runoff in the research area. A budget plan was created to estimate the cost of constructing these infiltration wells. The cost for constructing one infiltration well includes preparatory work, earthwork such as excavating for rain channels, filling, and leveling the ground, followed by the actual construction of the infiltration well and piping work.

The design planning for the infiltration structures follows the procedures outlined in the rainwater infiltration well design according to SNI 03-2453-2002 (BSN 2002). The number of infiltration structures is determined based on the volume of floodwater that will be retained and infiltrated into the structures. The effectiveness of reducing runoff that can be absorbed by the infiltration structures is calculated by dividing the total flood volume by the effective volume. This is in accordance with SNI 6897-2008 (BSN 2008a) and SNI 7934-2008 (BSN 2008b). According to the regulations of the Ministry of Environment Number 12 of 2009 regarding the utilization of rainwater, the number of infiltration wells required for a roof area of 50 m^2 is one unit, and for every additional 25-50 m^2 of roof area, an additional unit of infiltration well is required. The requirement for infiltration wells, $m^3/3m^3$/unit = 2.5 units, is equal.

Conclusion

1. The factors causing the emergence of puddles are the insufficient absorption of rainwater into the soil due to it being covered by paving.
2. There is a need to reduce the occurrence of puddles in the Sunan Giri University Surabaya area.
3. At least approximately 2 locations are needed for the placement of infiltration well holes.

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