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Infiltration Analysis of Paving Block Cover on the Basis of Embankment Soil Variations

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ABSTRACT

The large amount of infrastructure used causes less green land for rainwater absorption, so that rain that falls on the ground is not absorbed optimally. The resulting surface runoff is more than the amount of water absorbed. To overcome this, the method is to reduce the use of impermeable land cover (concrete pavement) and replace it with appropriate surface land cover. One of the efforts made is the use of pervious paving to reduce surface runoff and increase infiltration. This test aims to determine how much infiltration rate and capacity occurs when using paving block cover with variations in embankment soil. This research uses quantitative methods with an experimental approach using an artificial rain simulator. The soil used in this research is soil sourced from Lubuk Alung, Sarik River and Mount Sarik. The paving blocks used are in the form of hexagons which are usually used as ground surface pavement. Infiltration testing carried out several analyzes namely infiltration rate, infiltration capacity and cumulative infiltration. The results of this research show that good infiltration is the Sarik River landfill with the use of paving block cover, the infiltration rate value is 0.619-0.112 cm/minute, the infiltration capacity is 6.18 cm/hour, the cumulative infiltration is 8.97 and runoff occurs in the second minute. 09 and the chart intersects at the 30th minute. The results of infiltration testing using an artificial rain simulator showed that the use of paving block cover can increase infiltration thereby reducing the occurrence of run off.

Keywords: *Infiltration; Paving Block; Rain Simulator.*

INTRODUCTION

Based on the Central Statistics Agency (BPS), in 2020 the population in Padang City was 909,040 people. Every year the population of Padang City always increases. Judging by the end of 2021, the population of Padang City has increased to 913,448 people. The increase in population in Padang City is related to the many needs that must be met by the community, such as infrastructure needs.

The large amount of infrastructure used results in reduced green land for rainwater absorption, so that rain that falls on the ground is not absorbed optimally. The resulting surface runoff is more than the amount of water absorbed. With increasing global rainfall and the need for urban infrastructure reducing permeable surfaces, this causes flooding [2]. To overcome this, the method is to reduce the use of impermeable land cover (concrete pavement) and replace it with appropriate surface land cover. One of the efforts made is the use of pervious paving to reduce surface runoff and increase infiltration.

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One of pervious paving used is paving block. Paving blocks are building materials made from a mixture of cement, water and aggregate. Currently, paving blocks are widely used on ground surfaces such as housing, offices, schools and other building surfaces. Paving blocks have been widely known as an alternative technology to reduce runoff discharge and slow down water flow due to infiltration performance. Different paving surface configurations, block types and opening sizes play an important role in reducing runoff speed. Paving blocks are a type of porous concrete.

Porous concrete is a building material that is capable of passing rainwater down to the ground. Porous concrete has been widely used as a surface layer for permeable pavement. The effectiveness of these materials in managing stormwater runoff depends not only 3 on subsurface storage, but also on infiltration capacity during rainfall events [1]. Types of porous pavement include porous asphalt, porous pavement, gravel pavement systems, and include concrete brick pavement (paving block).
Based on the description above, it is necessary to carry out infiltration testing of paving block cover on the basis of variations in embankment soil (laboratory test) to obtain soil that is good for embankment with or without the use of paving block cover.

METHOD

This research uses quantitative methods with an experimental approach. Infiltration data collection using a designed artificial rain simulator was carried out at the Hydro Laboratory, Faculty of Civil Engineering, Padang State University.This test used 3 quarry locations in Padang City, namely Lubuk Alung, Sungai Sarik and Gunung Sarik quarries. Meanwhile, the paving blocks used were hexagonal and standard were used for ground surface pavement.

The artificial infiltration tool that has been planned is in the form of a rectangle made of acrylic glass with dimensions of 120cm x 60cm x 40cm and is equipped with an artificial rain simulator with the help of a shower device that has been connected to a flowmeter to calculate the amount of water entering the tool.

Figure 1 : Infiltration Testing Tank

Infiltration analysis testing was carried out using paving block cover and without paving block cover. The parameters that will be analyzed are infiltration rate, infiltration capacity, cumulative infiltration and the relationship between infiltration rate and surface runoff.

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Table 1 : Type of Testing

No	Land Resources	Type of Testing
1	Lubuk Alung	With Paving Block
2	Sungai Sarik	With Paving Block
3	Gunung Sarik	With Paving Block
4	Lubuk Alung	Withouth Paving Block
5	Sungai Sarik	Withouth Paving Block
6	Gunung Sarik	Withouth Paving Block

1. Infiltration Rate (f)
   Infiltration rate is the amount of water that enters through the soil surface per unit time [6]. Infiltration rate is obtained from water reduction data (ΔH) divided by testing time. To calculate the infiltration rate, use the following formula:
   $f = (\Delta H/t)$
   Information:
   f : Infiltration Rate (cm/minute)
   ΔH : Water surface height (cm)
   t : Testing time (minutes)

2. Infiltration Capacity (fp)
   Infiltration capacity is the maximum rate of water entering the soil expressed in mm/hour or cm/hour. The infiltration capacity value is obtained from the infiltration rate when the water level decreases constant [7]. To obtain the infiltration capacity value, it is obtained from the infiltration rate value of the Horton equation with the following formula:
   $fp = fc+(f0-fc)\ e^{-kt}$
   Information:
   fp : Infiltration capacity (cm/hour)
   fc : Fixed infiltration rate (cm/hour)
   f0 : Initial infiltration rate (cm/hour)
   It is : 2,718
   k : Geophysical constant
   t : Time (hour)

3. Cumulative Infiltration (F)
   Cumulative Infiltration is the amount of water that seeps into the soil in a period in units of (cm) or (m) depending on the parameters used. Cumulative infiltration is obtained from the Horton model derivative formula. The following is the formula for calculating cumulative infiltration.
   $F(t) = fc.t + ((f0-fc)/k\ (1-e^{-kt}))$
   Information:
   F(t) : Cumulative infiltration (cm)
   fc : Fixed infiltration rate (cm/hour)
   f0 : Initial infiltration rate (cm/hour)
   It is : 2,718
   k : Geophysical constant
   t : Time (hour)

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RESULTS AND DISCUSSION

1. Infiltration Rate (f)

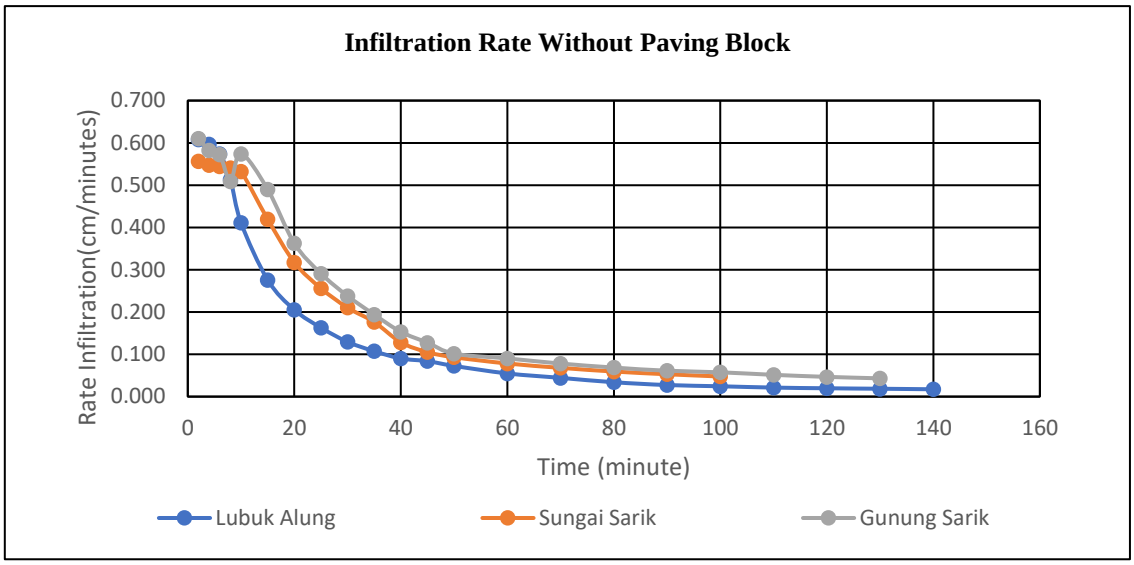

Figure 2 : Curve Infiltration Rate Without Cover Paving Block

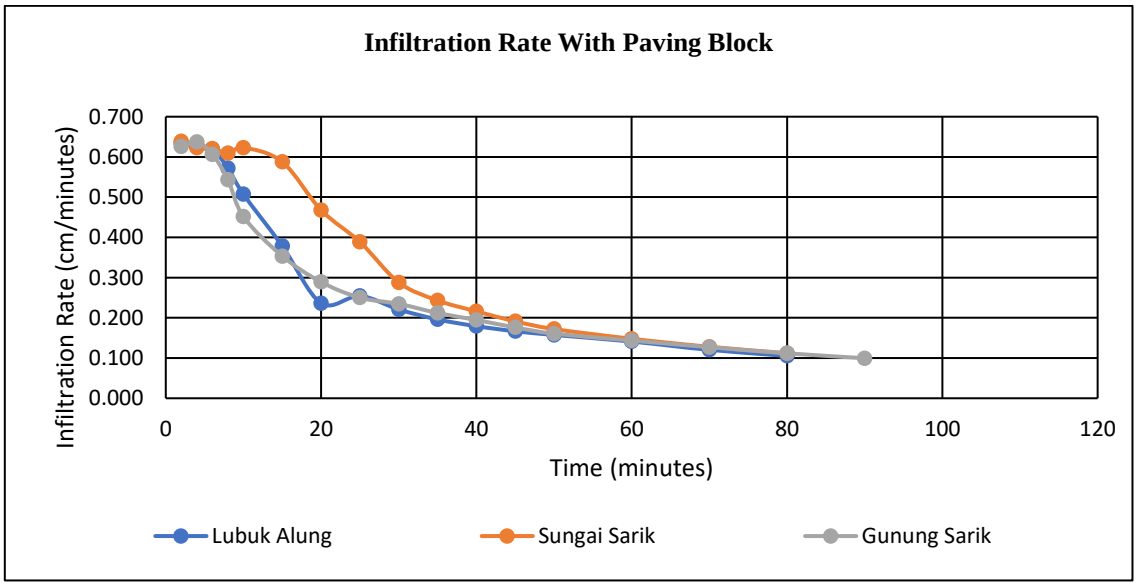

Figure 3 : Curve Infiltration Rate With Cover Paving Block

In Figure 2. Infiltration Rate Curve Without Paving Blocks, it can be seen that the infiltration rate of the Lubuk Alung embankment quarry started from 0.608 cm/minute, and the test was stopped when the water infiltration rate reached 0.017 cm/minute. Sarik River Quarry infiltration rate starts from 0.556 cm/minute and stops at 0.048 cm/minute. The Gunung Sarik Quarry infiltration rate starts from 0.610 cm/minute and stops at 0.043 cm/minute because the water has reached a constant value.

In Figure 3. Infiltration Rate Curve with Paving Block Cover, it can be seen that the infiltration rate of the Lubuk Alung embankment quarry using paving block cover starts from 0.634 cm/minute and stops at 0.105 cm/minute. The Sungai Sarik quarry starts at 0.639 cm/minute and stops at 0.112 cm/minute. The Gunung Sarik Quarry infiltration rate starts from 0.626

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cm/minute and stops at 0.100 cm/minute because it has reached a constant value.

2. Infiltration Capacity (fp)

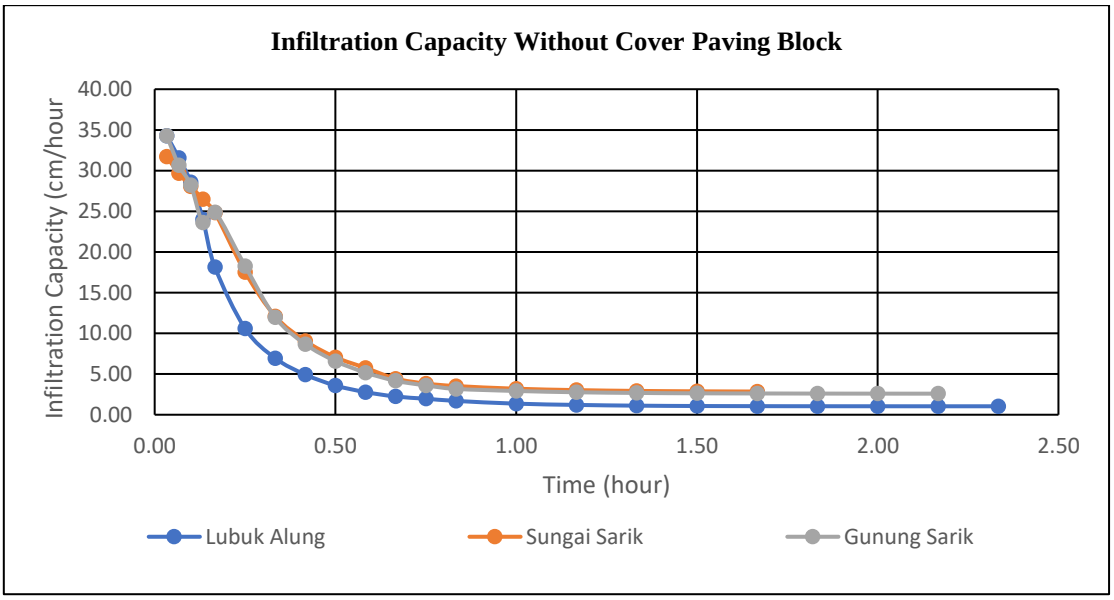

Figure 4 : Curve Infiltration Capacity Without Cover Paving Block

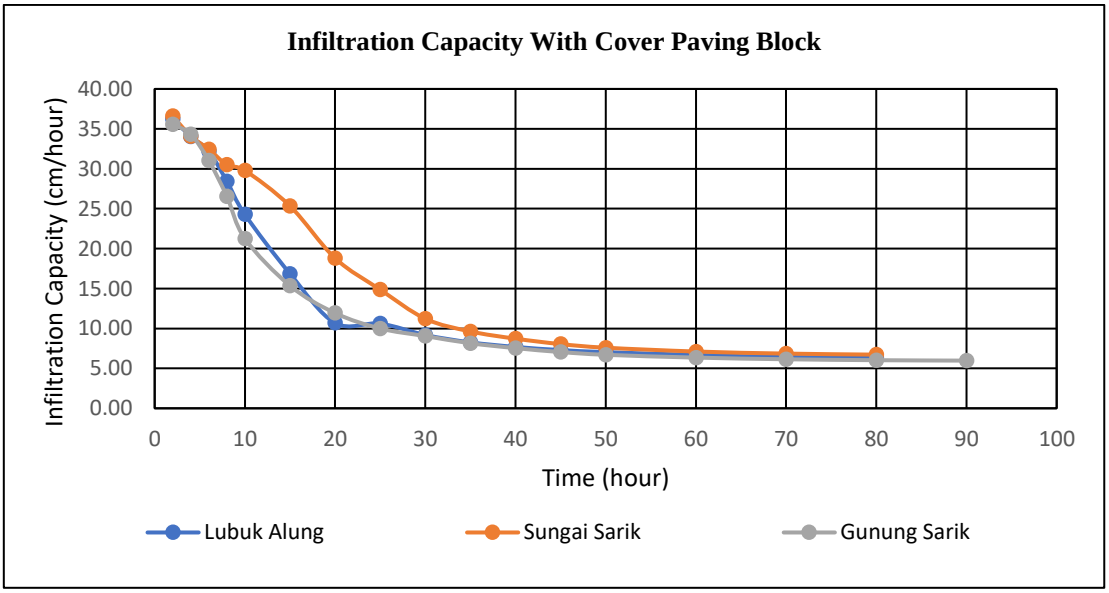

Figure 5 : Curve Infiltration Capacity With Cover Paving Block

In Figure 4. Infiltration Capacity Curve Without Paving Block Cover, it can be seen that the infiltration capacity of Lubuk Alung quarry was 1.04 cm/hour in 2.33 hours, Sungai Sarik quarry was 2.85 cm/hour in 1.67 hours, and Gunung Sarik was 2.59 cm/hour in 2.17 hours.

In Figure 5. Infiltration Capacity Curve with Paving Block Cover, it can be seen that the infiltration capacity of the Lubuk Alung quarry is 6.31 cm/hour in 1.33 hours, the Sungai Sarik quarry is 6.72 cm/hour in 1.33 hours, and the Gunung Sarik quarry of 5.97 cm/hour in 1.50 hours

3. Cumulative Infiltration (F)

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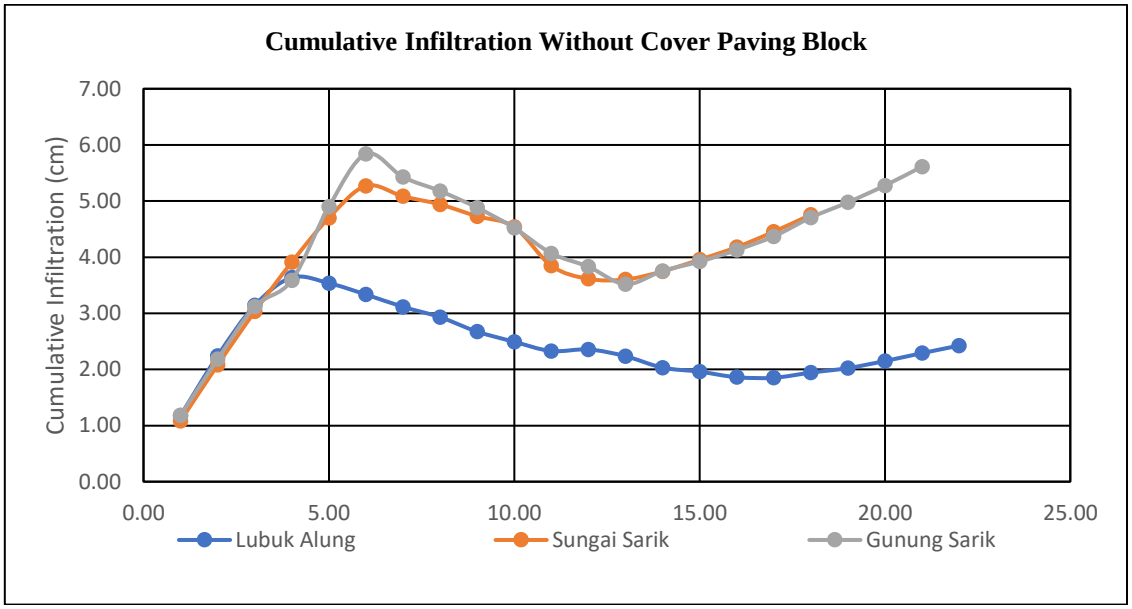

Figure 6 : Curve Cumulative Infiltration Without Cover Paving Block

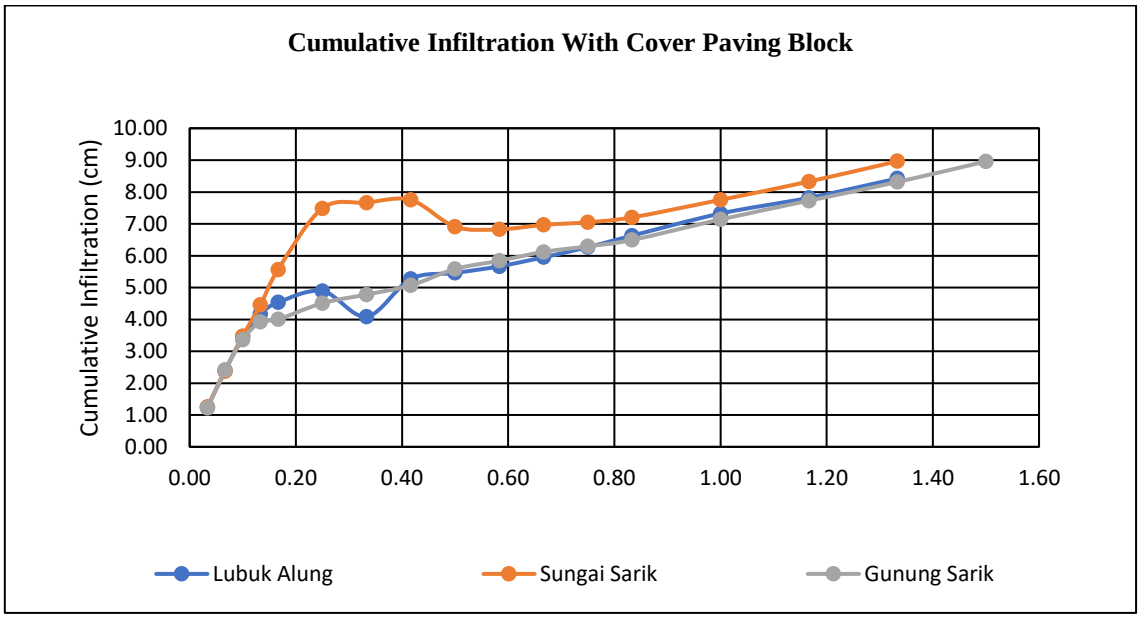

Figure 7 : Curve Cumulative Infiltration With Cover Paving Block

In Figure 7. Cumulative Infiltration Curve Without Paving Block Cover, it can be seen that the cumulative infiltration value of Lubuk Alung was 2.42 cm at 2.33 hours, the Sungai Sarik quarry was 2.76 cm at 1.33 hours, and the Gunung Sarik quarry was 2.76 cm at 1.33 hours. of 5.61 cm in 2.17 hours.

In Figure 8. Cumulative Infiltration Curve with Paving Block Cover, it can be seen that the cumulative infiltration value from the Lubuk Alung quarry was 8.43 cm at 1.33 hours, the Sungai Sarik quarry was 8.97 cm at 1.33 hours and the Gunung quarry Sarik was 8.96 cm at 1.50 hours.

Based on the analysis and results obtained, the largest infiltration value was obtained using

paving block cover in the Sarik River quarry with a rate of 0.639 - 0.112 cm/minute, an infiltration capacity of 6.72 cm/hour and a cumulative infiltration of 89.7 cm at 1.33 hours.

CONCLUSION

The results of infiltration tests using an artificial infiltration tool with an artificial rain simulator carried out in the laboratory using embankment soil in Padang City, namely Lubuk Alung, Sungai Sarik and Gunung Sarik embankment, concluded that the embankment land that is good for use in Padang City is embankment soil originating from quarries. The Sarik River has the largest infiltration capacity, namely 67.2 mm/hour with paving block cover and 28.5 mm/hour without paving block cover with medium-fast and moderate infiltration classifications. The use of paving blocks can increase infiltration and reduce surface flow, thereby delaying flooding or standing water.

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