A Green Infrastructure SDGS Num 11: Approach Planning Design Model Reliability of Permeability and Concrete Quality Rural Roads P3MD Program in Wonogiri

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Abstract. Design planning permeability and quality of rural concrete road construction work in the Program Pembangunan dan Pemberdayaan Masyarakat Desa (P3MD) of the Ministry of Villages, Development of Disadvantaged Regions and Transmigration in Wonogiri, which is environmentally friendly in accordance with the sustainable development goals of SDGs Number.11 Villages "Sustainable Cities and Community", is the urgency of global action to reduce the impact of climate change and overcome challenges in developing a village road infrastructure model that is sustainable and leads to Green Infrastructure. Testing the permeability of village road construction materials using a rational classification method based on the Unified Soil Classification System, ASTM and International Nomenclature Darcy's Law by calculating the input discharge of rainwater seeping into the soil through the pores of road construction using a rational method, testing the compressive strength of concrete roads using Rebound Hammer / Concrete Hammer Test method, SNI Standard 03-4430-1997. The results of the input volume of rainwater seeping into the ground through the pores (run off) of rural roads construction in Wonogiri one year is 724,866 m³. The average compressive strength of concrete roads from the hammer test results for concrete road test is 290 kg/cm² > K-225 kg/cm², than the desired construction, namely; standard deviation; (S=1.75), coefficient of variation (Kv= 7.35%), indicating that the data taken has a sufficient level of accuracy, while the uniform data is quite representative of the road section studied.

1 Introduction

In 2014 the Government of the Republic of Indonesia established Law no. 6 of 2014 concerning Villages. The vision of the Village Law is to create a village that is advanced, strong, independent, just and democratic, and has full authority to manage/regulated itself to

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achieve the welfare of the village community. In Wonogiri Regency, there are 251 villages with Dana Desa (DD) allocations from the Central Government. Ministry of Villages & Development of Disadvantaged Villages & Transmigration Government Policy regarding village development. In Wonogiri District there are 9 villages; The villages of Wonoharjo, Wonokarto, Sonoharjo, Manjung, Purwosari, Purworejo, Bulusulur, Pokoh Kidul, and Sendang Village have received a village fund budget program since 2016. approximately 1-1.5 billion rupiah each year for activities to improve rural infrastructure facilities in Wonogiri sub-district. Rural infrastructure improvement activities are aimed at improving village roads, including by 2022 building concrete road infrastructure that connects environmental roads between hamlets and between villages (Fig. 1) [1].

Fig. 1. Map of Village Road Research Locations in the Wonogiri District area

In 2022, 9 villages in Wonogiri District will have received financing for infrastructure development, some of which will be used to build concrete roads with a total of ± IDR 10,065 billion, the quantity of concrete roads that can be made is 5,280 meters long [2].

Fig. 2. Priority Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) (Fig. 2) are a global and national commitment in an effort to improve community welfare, including 17 goals, namely (1) No Poverty; (2) Zero Hunger; (3) Healthy and Prosperous Life; (4) Quality Education; (5) Gender Equality;
Clean Water and Adequate Sanitation; (7) Clean and Affordable Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation and Infrastructure; (10) Reducing Inequality; (11) Sustainable Cities and Community; (12) Responsible Consumption and Production; (13) Handling Climate Change; (14) Ocean Ecosystem; (15) Land Ecosystem; (16) Peace, Justice and Strong Institutions; (17) Partnership to Achieve Goals.

Environmentally friendly road construction work in accordance with the sustainability goals of SDGs Num 11 "Sustainable Cities and Community", SDG Num 11 underlines the urgency of global action to reduce the impacts of climate change and overcome the challenges it faces, through the development of sustainable infrastructure that leads to Green Infrastructure.

Efforts to increase the strength of concrete materials do not only pay attention to improving the quality of basic materials (aggregate, cement and water), which includes implementation stages; measuring materials, mixing, transporting, pouring, compacting and maintaining, in this case community members must have basic knowledge of concrete quality construction which is needed to assist in maintaining the quality of work implementation and the quality of the concrete road work being made.

2 Method

In this research, environmental road samples were taken in 9 villages in Wonogiri District, in stages research as follows:

2.1 Research stages

This research in detail calculates the input discharge of rainwater seeping into the soil through the pores (run off) of road construction using a rational classification method based on the Unified Soil Classification System, (ASTM) and International Nomenclature. Darcy's law explains the ability of water to flow through cavities (pores) in the soil and the properties that influence this. The flow velocity is calculated based on the gross cross-sectional area of the soil. Because water can flow through the pore cavities of the embanked soil in the design of the village road construction model, the speed of seepage flow through the pore cavities of the soil.

Measuring the compressive strength of test object samples taken randomly on road test fields in 9 villages in Wonogiri District. This will allow you to clearly see the difference in compressive strength in each area of the road test, so that you can get a sample that represents the quality and quality of the concrete road. The process of carrying out this research uses the testing method, namely a research method by conducting experiments in the laboratory on test objects to obtain thorough and systematic results.

2.2 Equipment and steps

a. Equipment

Testing of Structural Elements by examining planning documents and Budget Plans (RAB) for village roads to calculate material volumes, especially pore numbers in village road construction materials, to measure the quality of concrete using Type N and NR Concrete Hammers (Fig. 3). This is intended as a reference and guide in carrying out concrete surface hardness tests in the field.

b. Steps:

1) A concrete hammer tool is a steel hammer that is driven by a spring force which, when released, will hit a steel slider against the concrete surface;
2) Hardness is hardness which is indicated by the magnitude of the elastic value;
3) Value is the reading value indicated by the tool after the steel slide hits the concrete surface;
4) Hammer is a concrete hammer test tool that can be used for testing normal concrete structures that are not equipped with a data recording device (Recorder);
5) Hammer is a concrete hammer testing tool that can be used for testing normal concrete structures and is equipped with a data recording device (Recorder).

![Concrete Hammer Test Equipment](image)

**Fig. 3.** Concrete Hammer Test Equipment with NR type concrete hammer

### 2.3 Data analysis

a. The results of classifying the embankment soil were analyzed based on the Unified Soil Classification System, ASTM and International Nomenclature. Water content in backfilled sand ($w$)(%) = \[\text{___} \times 100\%\]
b. To calculate the wet or humid condition ($\gamma_b$) = \[\text{___}\], meanwhile
c. Weight of backfilled sand in dry conditions ($\gamma_d$) = \[\text{___}\]
d. Porosity ($n$) = \[\text{___}\] Pore number ($e$) = \[\text{___}\]
e. To analyze the ability of water to flow in cavities (pores) Darcy's Law Flow velocity is calculated based on the gross cross-sectional area of the soil. \[v_s = \text{___} \text{vsIA}\]
f. The input discharge of rainwater seeps into the soil through pore cavities using a rational method. \[Q = 0.278 v_s I A\]
g. Results of the compressive strength test on concrete road sample specimens taken were cylindrical in shape with a diameter of 15 cm and a height/thickness of 20 cm using a compression testing machine, to obtain the maximum compressive load that the test specimen could withstand. In this way, the maximum load on the test object can be assessed as to the compressive strength. The concrete compressive strength data used is the average concrete compressive strength, and the standard deviation of the data is calculated using the formula:

\[
\sigma = \sqrt{\frac{1}{n-1} \sum_{i=0}^{n} (x_i - \bar{x})^2}
\]

h. Then the coefficient of variation is measured using the formula:

\[
KV = \left(\frac{S}{\text{Mean}}\right) \times 100\%
\]
3 Result and discussion

Application model RAB Dana Vers.3.1 (Fig. 4 and Fig. 5) as humanitarian engineering technology useful for helping the rural community in civil engineering planning to calculate the take of sheet volume, especially in terms of material pore numbers and the quality of concrete construction for village roads.

Fig. 4. Rural road bill of quantity plan (RAB ver 3.1)

Fig. 5. The result of application model RAB Dana Vers.3.1 for helping in civil engineering planning to calculate the take of sheet and detail engineering design

The design of the rural road construction model in Wonogiri sub-district uses a combination of concrete construction (Fig. 6) and stone masonry construction with the aim of infiltrating rainwater into the soil through the pores of rock cavities and filled sand, with the following specifications:

- Type of way: Rebate Bet on Rell
- Design Quality: K225 kg/cm²
- Concrete Width: 2 x 60cm
- Thickness: 12cm
- Trim width: 15cm x 60cm (middle)
- (Stone 3-5): 2 x 15cm x 50cm (edge/shoulder)
3.1 Permeability analysis

The use of empty/repaired stone masonry in the middle of the road and the shoulder of the village road is a construction design to allow infiltration of rainwater into the ground, with the following design: Most of the backfill sand used in the design of village road construction models in Wonogiri sub-district contains a mixture of uniform particles or several different particle sizes. Backfill sand does not only consist of sand but can be mixed with clay grains, silt or perhaps also a mixture of organic materials. The size of the backfill sand content can vary from greater than 100mm to sizes smaller than 0.001mm, classification is based on the Unified Soil Classification System, ASTM and International Nomenclature. The use of backfill sand in the implementation of village road construction is a type of non-dense mixed grain sand (High Permeability).

From the results of sampling the fill sand in the village road construction model design in Wonogiri subdistrict with an average sample weight (W) of 0.120 m$^3$, it has an average wet weight (Ww) of 18 gram with a specific gravity of sand (Gs) = 2.62, calculated water content for the value of condition of filled sand in the design of village road construction models with n=41.1%, e=0.965, w=12.5%, $\gamma_b$ = 14,72kN/m$^2$, $\gamma_d$ = 13,08kN/m$^3$

Darcy’s method explains the ability of water to flow through cavities (pores) in the soil and the properties that influence it. The flow velocity is calculated based on the gross cross-sectional area of the soil. Because water can flow through the pore cavities of the embanked soil in the village road construction model design, the flow rate of seepage through the pore cavities of the soil.

From the results of sampling the embankment sand in the village road construction model design in Wonogiri sub-district with an average sample weight (W), the speed of groundwater seepage/permeability through the pores of the embankment soil, in this case the embankment sand used on village roads Soil permeability range values (k)= 10$^{-2}$ - 10 mm/sec, with Mixed grain sand is not dense (High Permeability) Rainfall and rainy days in Wonogiri Regency at the 3 year return period is an average of 1375 mm/hour (Fig. 7); the 1 year birthday is the largest at 810 mm/hour. The design of the village road construction model in Wonogiri sub-district adapts environmentally friendly construction according to SDGs 13, by calculating the input discharge of rainwater to seep into the ground through the pores of the road construction using a rational method.
Fig. 7. Rainfall and rainy days in Wonogiri Regency 2020-2022

Source: https://wonogirikab.bps.go.id/indicator/151/164/1/curah-dan-hari-hujan.html

The realization of village road construction using village funds in 2022 is IDR. 3,408,960,000, with the length of the village road being built being 5,280 meters (Table 3). Calculating the volume of input discharge of rainwater seeping into the ground through the pores of the road construction being built is (Fig. 8). The calculation results of the input volume of rainwater seeping into the ground through the pores of village road construction in Wonogiri sub-district in one year is 724,866 m³.

Table 3. Realization of Village Funds for Village Road Construction in Wonogiri, 2022

<table>
<thead>
<tr>
<th>No</th>
<th>Village Location</th>
<th>Village Fund Ceiling (Rp)</th>
<th>Realization of Village Roads (Rp)</th>
<th>Length of Village Road (m)</th>
<th>Volume Water Infiltration (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SENDANG</td>
<td>842,806,000</td>
<td>614,295,000</td>
<td>935</td>
<td>128,095</td>
</tr>
<tr>
<td>2</td>
<td>POKOH KIDUL</td>
<td>996,060,000</td>
<td>180,675,000</td>
<td>275</td>
<td>7,675</td>
</tr>
<tr>
<td>3</td>
<td>PURWOREJO</td>
<td>1,287,994,000</td>
<td>505,890,000</td>
<td>770</td>
<td>105,490</td>
</tr>
<tr>
<td>4</td>
<td>BULUSULUR</td>
<td>1,121,580,000</td>
<td>252,945,000</td>
<td>385</td>
<td>52,745</td>
</tr>
<tr>
<td>5</td>
<td>PURWOSARI</td>
<td>1,068,037,000</td>
<td>433,620,000</td>
<td>660</td>
<td>90,420</td>
</tr>
<tr>
<td>6</td>
<td>WONOHARJO</td>
<td>1,371,235,000</td>
<td>325,215,000</td>
<td>495</td>
<td>67,815</td>
</tr>
<tr>
<td>7</td>
<td>MANJUNG</td>
<td>1,243,033,000</td>
<td>469,755,000</td>
<td>715</td>
<td>97,955</td>
</tr>
<tr>
<td>8</td>
<td>WONOKERTO</td>
<td>895,588,000</td>
<td>469,755,000</td>
<td>715</td>
<td>97,955</td>
</tr>
<tr>
<td>9</td>
<td>SONOHARJO</td>
<td>1,238,824,000</td>
<td>216,810,000</td>
<td>330</td>
<td>45,210</td>
</tr>
<tr>
<td></td>
<td>Amount</td>
<td>10,065,157,000</td>
<td>3,468,960,000</td>
<td>5,280</td>
<td>723,360</td>
</tr>
</tbody>
</table>

Fig. 8. Realization of development with volume of water infiltration through road pore cavities
3.2 Compressive strength analysis of concrete quality

The test results were carried out at the age of 28 days, from the compressive strength test carried out using the Concrete Hammer Test tool, it was obtained that the average value of the reading was corrected to the final average value according to the inclination of the blow if the direction of the blow was not horizontal. The results of the compressive strength test are as follows (Fig. 9).

![Fig. 9. Sampling of compressive strength of concrete roads Rebound Hammer/Concrete Method hammer test](image)

<table>
<thead>
<tr>
<th>Test Field Code</th>
<th>SDG-01</th>
<th>PKH-01</th>
<th>BLR-01</th>
<th>WNH-01</th>
<th>WNK-01</th>
<th>SNH-01</th>
<th>PW-01</th>
<th>PS-01</th>
<th>MJ-01</th>
<th>Re-average</th>
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<tbody>
<tr>
<td>R Maximum</td>
<td>29</td>
<td>28</td>
<td>27</td>
<td>26</td>
<td>22</td>
<td>30</td>
<td>30</td>
<td>29</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Minimum R</td>
<td>23</td>
<td>24</td>
<td>18</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>24</td>
<td>23</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Coefficient of Variation (Kv)</td>
<td>5.8</td>
<td>4.5</td>
<td>9.3</td>
<td>7.8</td>
<td>5.0</td>
<td>11.0</td>
<td>8.2</td>
<td>6.0</td>
<td>7.9</td>
<td>7.3</td>
</tr>
<tr>
<td>Baku intersection</td>
<td>1.49</td>
<td>1.15</td>
<td>2.18</td>
<td>1.75</td>
<td>1.05</td>
<td>2.53</td>
<td>2.15</td>
<td>1.54</td>
<td>1.96</td>
<td>1.75</td>
</tr>
<tr>
<td>R Average Quality (Kg/cm²)</td>
<td>25.3</td>
<td>25.2</td>
<td>23.3</td>
<td>22.3</td>
<td>20.6</td>
<td>22.8</td>
<td>26</td>
<td>25.5</td>
<td>24.6</td>
<td>23.9</td>
</tr>
</tbody>
</table>

**Table 4. Compressive strength test results for village road concrete construction in Wonogiri, 2022**

![Graph of Compressive Strength of Village Road Concrete Quality](image)

Based on **Table 4**, it shows that the compressive strength of concrete on the concrete road surface is varied. The table above also shows the average compressive strength figures for concrete roads from the concrete road test fields of the 9 villages in the Wonogiri subdistrict studied. It shows that the average compressive strength of concrete roads in the Wonogiri subdistrict is; 290 Kg/cm² The highest compressive strength of concrete roads is in Purworejo village, namely; 323kg/cm² , while the lowest compressive strength was in Bulusulur village, namely; is 261kg/cm². The estimated compressive strength of concrete roads in 9 villages in Wonogiri sub-district is still greater than the desired construction forecast, namely; K-225 (Fig. 10).
Normality testing on the research data above uses the Liliefors method, where in this method the distribution of data from members of the data group must be normal. The test above shows that the average standard deviation (S) of the compressive strength data taken is; (S=1.75) with an average coefficient of variation (Kv= 7.35%). This shows that the data taken has a sufficient level of accuracy, while the variation in the data shows the uniformity of the concrete road compressive strength data taken which is quite representative of the road section studied.

4 Conclusion

The input volume of rainwater seeping into the ground through the pores (run off) of rural roads construction in Wonogiri is 724,866m³. The average compressive strength of concrete roads from the hammer test results is 290kg/cm²> K-225 kg/cm² than the desired construction; deviation; (S=1.75), coefficient of variation (Kv= 7.35%).

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References