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Subgrade Feasibility Analysis for Tourist Access Roads in Senggani Gorge, Tulungagung Using Laboratory CBR Testing

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ABSTRACT

Highways have an important role in the economic and tourism sectors, providing easy accessibility and accelerating regional growth. Senggani Gorge, a tourist attraction in Nglurup Hamlet, Sentang District, Tulungagung Regency, is the main attraction with the charm of waterfalls and natural coffee plantations in the highlands. However, accessibility constraints arise because the path to the tourist attraction is still slippery and bumpy clay. Clay soil conditions pose access difficulties, so more research is needed to understand the potential use of clay soil as a base layer of road pavement. This study focused on a research system that involved soil sampling on the access road to Senggani Gorge. Experimental methods were used to evaluate the effect of using clay subgrades on such tourist road access. The laboratory CBR test was conducted to test the strength of clay subgrade in road pavement construction, with the main aim to determine the impact of its use on tourist access to Senggani Gorge in Tulungagung. The results showed the percentage of CBR in collision variations 10, 25, and 56, as well as a comparison with research in Nglurup Hamlet which reached a CBR value of 27%. These findings are expected to provide a dimension of comparison and generalization of results, broadening understanding of the use of clay soils as road construction materials in various locations.

Keywords: *California Bearing Ratio (CBR); Clay Soil; Laboratory Test.*

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INTRODUCTION

An important aspect of the economic and tourism sectors is highways. Highways are roads formed by humans with their shapes, sizes and types of construction so that they can be used for the passage of people, goods, and vehicles from one place to another and accelerate regional growth, one of which is the ease of accessibility of the tourism sector [1]. Senggani Gorge is one of the tourist attractions located in Nglurup hamlet, Sendang District, Tulungagung Regency, is one of the mainstay tourist attractions of Tulungagung City because of the charm of its waterfall and coffee plantations that are still natural because it is located in the highlands. In addition to the natural beauty presented, there is an obstacle, namely access, to reach the tourist object of the gorge, the access is still in the form of slippery clay soil and the contours are undulating because of the nature of the clay, which is expansive [2][3]. With the condition of the clay soil, access to the Senggani Gorge tourist attraction becomes difficult [4]. Therefore, further research is needed regarding the use of clay soil as a base soil layer so that later it can be maximized in the road pavement layer [5][6].

Clay soil is a considerable problem in the world of transportation, especially in the planning of road pavement layers. The pavement layer must have a good level of stability and flexibility so that the service can be maximized. In addition, the road pavement layer is composed of several layers including the subgrade soil layer, the lower foundation layer (base), the upper foundation layer (subbase), the middle layer (base course) and the upper layer (wearing course) [7][8]. The research system used is in the form of sampling at the location, namely on the access road to the senggani ravine[9].

In order to determine the level of influence of the use of clay soil subgrade on the access to the Senggani Gorge tourist road, an experimental method was used with direct research in the laboratory using the Laboratory CBR test where this study was carried out to test the influence of a variable on other variables or to test how the causal relationship between one variable and another variable was used [10][11]. The purpose of this study is to determine the strength of the use of subgrade clay soil in the construction of road pavement in the tourist access of the Tulungagung Senggani Gorge. The novelty in this study lies in the innovative approach in the selection of construction materials, as well as efforts to compare the test results with previous research in Nglurup Hamlet. This is expected to provide a comparative dimension and generalize the results, expanding the understanding of the use of clay soil as a road construction material in various locations.

Street

Road is a land transportation infrastructure that includes all parts of the road, including connecting buildings, complementary buildings and their equipment intended for traffic, which are located at ground level, above ground level, below ground level, and/or water, as well as above water level, except rail roads, truck roads, and cable roads[12]. The classification of roads according to their roles and functions is:

1. Arterial Roads
   Arterial roads are public roads that function to serve the main transportation with the characteristics of long-distance travel, high average speed, and the number of access roads (access) is effectively limited
2. Collector's Road
   Collector road, is a public road that functions to serve collector or dividing transportation with the characteristics of medium-distance travel, medium average speed, and the number of access roads is limited.
3. Local Roads
   Local roads are public roads that function to serve local transportation with the characteristics of short-distance travel, low average speed, and unrestricted access roads.
4. Neighborhood Road
   Environmental roads are public roads that function to serve environmental transportation with the characteristics of short-distance travel, and low average speed.

Subgrade

Subgrade soil is a crucial component in road construction, which generally consists of three essential layers, namely the cover layer, pavement, and the subgrade itself[13]. A special focus on the feasibility analysis of the subgrade of tourist access roads in Jurang Senggani, Tulungagung, is very important because of its role as a structural supporting element for the road pavement layer. The subgrade serves as the main foundation that supports the load of the pavement layer. The success of road construction and its durability level is highly dependent on the strength and carrying capacity of the underlying soil. Therefore, subgrade feasibility analysis involves soil basin testing (CBR) in the laboratory, a relevant and essential method for measuring the carrying capacity of subsoils. This study will delve deeper into aspects such as water content distribution, soil density, and other geotechnical characteristics that affect the quality of *subgrades*.

METHOD

This study uses research data with an experimental method because it is to determine the influence of soil use on the subgrade layer. Starting from soil sampling from the Senggani Gorge tourist site and then tested using *the California Bearing Ratio* (CBR) Laboratory test equipment as primary data. Meanwhile, the secondary data is in the form of a reference for CBR calculation and testing, namely SNI 03 – 1744 – 1989.

Research Location

Subgrade soil test sampling at the tourist site of the Senggani Gorge in Nglurup hamlet, Sendang District, Tulungagung Regency, and the test location is at the Civil Engineering Laboratory of Kadiri University, Kediri

Figure 1. Sampling location of clay *soil subgrade* test

CBR (*California Bearing Ratio*)

The CBR test aims to find out the comparison between trial loading and standard loading, and is expressed in percentages[10][11]. The CBR price is the carrying capacity of soil that is compacted through compaction at a certain moisture content compared to raw materials in the form of crushed stone with a CBR score of 100% in withstanding traffic loads[14]. Therefore, the CBR score is a percentage or ratio of the bearing capacity of the soil compared to the carrying capacity of standard broken stone at the same penetration score (0.1 inches and 0.2 inches) [15]. Soils can be classified on their use for subgrade based on the CBR score of the soil type[16]. And the CBR values of the subgrades presented in Table 1:

Table 1. CBR Values from Subgrades

CBR Value	**CBR Grades for Subgrades**
> 24%	Excellent
8 – 24%	Good
5 – 8%	Fair
3 – 5%	Poor
2 – 3%	Very Poor


Figure 2. Inserting a Subgrade Soil Sample into a CBR Test Mold


Figure 3. Subgrade Soil Compaction Process

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Figure 4. CBR (*California Bearing Ratio*) Test Process

Table 2. CBR Value Classification

CBR	Description
0 – 3	Very Poor
3 – 7	Poor
7 – 20	Fair
20 – 50	Good
> 50	Excellent

Table 3. Results of Clay Soil Density

Density, mold no.	10 Collision	25 Collision	56 Collision
Mass of test piece + mold, g	6850	7839	8612
Mass of mold, g	4290	4290	4290
Mass of wet test piece, g	2560	3549	4322
Mold content, cm3	3091	3091	3091
Wet density (), g/cm3	0,83	1,15	1,40
Dry density (), g/cm3	0,71	0,99	1,21

RESULTS AND DISCUSSION

Penetration and Calibration

It is known that the test material is in the form of clay soil. CBR testing was carried out in the laboratory using three test samples, with each test sample being 10 bumps, 25 bumps, and 56 bumps with a maximum dry density value of 0.99 gr/cm3 (According to the results in Table 2). The results of the CBR Test are presented in Table 4 below.

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Table 4. Penetration and Calibration Readings of CBR (*California Bearing Ratio*) Values

Time (Minutes)	Penetrasi		10 Collision		25 Collision		56 Collision	
			Load Gauge Watch Reading	Penetration Load	Load Gauge Watch Reading	Penetration Load	Load Gauge Watch Reading	Penetration Load
	mm	in	devisi	kn	devisi	kn	devisi	kn
0	0	0	0	0	0	0	0	0
1/4	0,32	0,0125	4	0,5464	6	0,8196	10	1,3659
1/2	0,64	0,025	5	0,6830	7	0,9562	22	3,0050
1	1,27	0,050	7	0,9562	11	1,5025	32	4,3710
1 1/2	1,91	0,075	8	1,0927	15	2,0489	39	5,3271
2	2,54	0,10	10	1,3659	18	2,4587	43	5,8735
3	3,81	0,15	11	1,5025	21	2,8685	50	6,8297
4	5,08	0,20	13	1,7757	24	3,2782	57	7,7858
6	7,62	0,30	15	2,0489	30	4,0978	73	9,9713
8	10,16	0,40	17	2,3221	34	4,6442	83	11,3372
10	12,7	0,50	20	0,0683	37	0,0683	95	0,0683

Table 3 presents the CBR value data for each impact, which is multiplied by the calibration value of the proving ring K, which has a calibration value of 0.136593 kN. The readings of this watch are affected by the degree of penetration. A graph of the penetration results of 10 collisions, 25 collisions, and 56 collisions will be presented as seen in Figure 5 below.

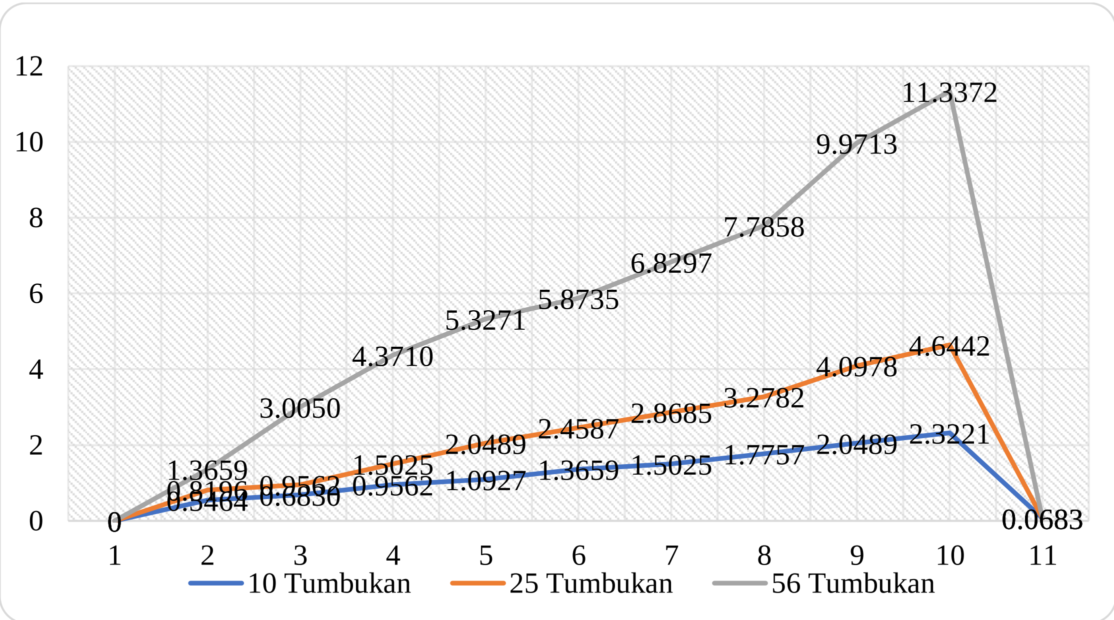

Figure 5: Graph of CBR (*California Bearing Ratio*) Test Results

CBR Value

In the context of the previous sentence, the CBR (California Bearing Ratio) value reflects the percentage of the soil's bearing capacity at impact variations of 10, 25, 56. These measurements are reflected in the test results organized in Table 5. The CBR value is a significant indicator of the strength and bearing capacity of the soil at a certain depth, especially when the soil is

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subjected to impact loads.

Table 5. CBR and Dry Density Values

	Number of Collisions		
	10	**25**	**56**
CBR Value %	8,87	10,23	11,60
Dry Density, gr/cm3	0,71	0,99	1,21

The percentage of CBR was calculated based on penetration in collision variation 10 had a CBR value of 8.87%, collision variation 25 had a CBR value of 10.23% and collision 56 of 11.60%. Further analysis can be performed to understand the differences in soil performance at various impact variations, which can provide additional insights regarding the mechanical characteristics and strength of the soil under those test conditions.

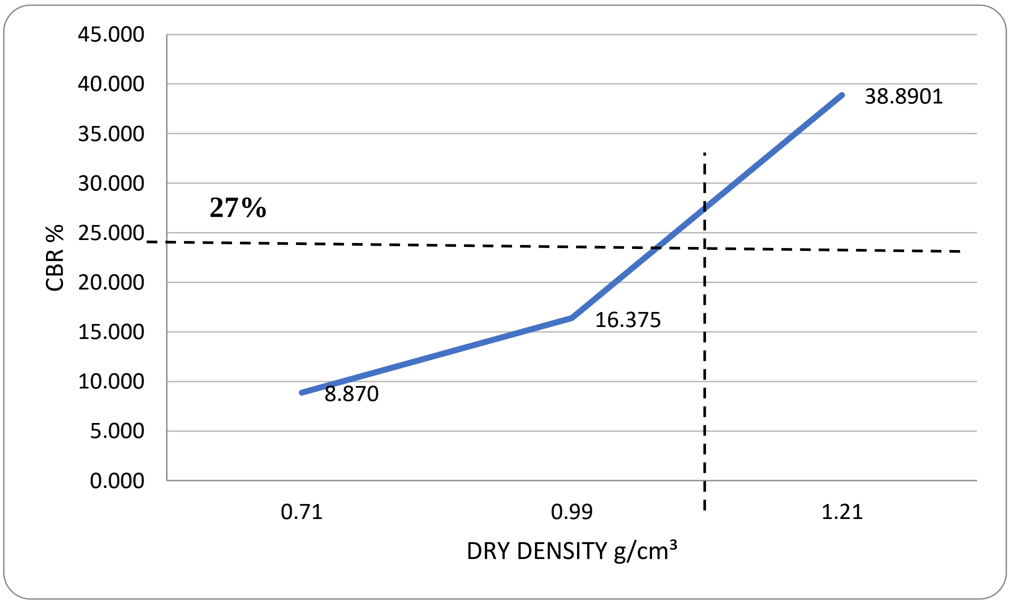

Figure 6. CBR Design Graph

The results of CBR Design obtained a score of 27% with the "Good" soil category according to ASTM D1883.

CONCLUSION

Based on the results of research conducted in Nglurup Hamlet, Sendang District, Tulungagung Regency, with testing in the laboratory of Kadiri University, it was found that the CBR value of soil at the location reached 27%. These findings imply that the soil in the region can be categorized as a soil with good carrying capacity. These positive results provide an indication that the soil has sufficient capacity to support structures, such as road pavements, without requiring significant corrective actions or increased carrying capacity. As a suggestion, the study could consider the integration of sustainability aspects in its analysis, including the environmental impact of clay soil use. In conclusion, this research not only meets the needs of road infrastructure in the Senggani Gorge, but also opens up the potential for innovative and sustainable solutions in the development of tourist roads in terms of Development.

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