CIVED
Journal of Civil Engineering and Vocational Education

EISSN: 2622-6774
Vol XX No.X Month Year
http://cived.ppj.unp.ac.id/index.php/CIVED

Analysis of Soil Bearing Capacity in Kauman, Tulungagung as a Subgrade For Flexible Pavement

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Received 18th April 2024; Revision 22th May 2024; Accepted 30th June 2024

ABSTRACT

This research aims to evaluate the bearing capacity of the soil in Kates Village, Kauman District, Tulungagung Regency, as a subgrade in flexible pavement through California Bearing Ratio (CBR) testing in the Civil Engineering Laboratory of Kadiri University. The tests were conducted with 56, 25, and 10 blows to determine their impact on the soil's density, strength, and stability. The results showed that soil with 56 blows had the highest CBR value of 28.660% at a 5.08 mm penetration, indicating excellent bearing capacity. The soil with 25 blows showed a CBR value of 17.060%, which is quite high, ensuring adequate stability and bearing capacity. Conversely, the soil with 10 blows had the lowest CBR value of 4.094%, indicating the need for additional compaction before being used in road construction. This research confirms that the number of blows has a significant impact on soil quality, with more intensive compaction improving the soil's density and stability. The final design CBR value obtained was 16%, leading to the conclusion that the soil in this area can be used as a subgrade for flexible pavement.

Keywords: *Soil Bearing Capacity; Soil Stability; CBR Design; Subgrade; Flexible Pavement*.

INTRODUCTION

Soil is one of the main components in the ecosystem formed from mineral and organic materials that undergo weathering and decomposition processes. In construction, the function of soil can be divided into two main categories, namely as a construction material itself and as a medium that supports the structure. For example, in the field of road construction, soil can be a subgrade on flexible road pavement [1].

Subgrade soil is the soil layer that forms the base of the pavement. The subgrade soil acts as a support for the load received from the overlying pavement layers and ensures uniform load distribution to deeper soil layers. As a road foundation, subgrade soil must have a strong and stable bearing capacity [2].

Subgrade bearing capacity is a key element in highway construction planning. If the soil does not have sufficient bearing capacity, significant deformation or settlement will occur which can damage the pavement layer [3]. Therefore, it is very important to know the bearing capacity of the soil [4]. One of the main parameters used to evaluate the quality of a soil subgrade is its California Bearing Ratio (CBR) value [5].

California Bearing Ratio (CBR) is a value used to measure the strength and bearing capacity of soil or materials used in pavement construction. Higher CBR values indicate that the soil has good strength, while low CBR values indicate that the soil may require improvement or stabilization to meet construction requirements [6].

The purpose of this research is to determine the bearing capacity of the soil in Kates Village, Kauman Subdistrict, Tulungagung Regency through the CBR test at the Civil Engineering Laboratory of Kadiri University so that it can determine whether the soil can be used as a subgrade in the planning and design of flexible pavement in the area.

METHOD

Research Location

The research location is the place where the research was conducted. with the reference point of soil sampling at the location of Kates Village, Kauman, Tulungagung. This research study was then conducted at the Civil Engineering Laboratory of Kadiri University.

Retrieval Method

Data collection involves physical data obtained through direct sampling techniques. The data required in the analysis are primary data such as field surveys regarding environmental conditions to the determination of representative zones for soil sampling, and secondary data such as previous studies and research related to soil characteristics in this area [7].

Sampling

Generally, there are two types of soil samples, namely disturbed soil and undisturbed soil samples [8]. Soil samples are taken from disturbed soil (disturbed soil), which are soil samples influenced by the surrounding environment. Sampling was conducted after observations and site surveys, which were selected as representative of the research area as a whole. The tools used for sampling were crowbar and hoe.

Figure 1. Sampling location

Figure 2. Soil sampling

Laboratory Testing

Take 25 kg of soil with a depth of 0.8 meters from the predetermined location, then brought to the laboratory. The soil was prepared in a dry state, pounded with a pounding tool, and sieved using a no.4 sieve. Next, the soil was divided into 3 samples each weighing 5 kg. Each sample was mixed evenly with 700 g of water, put into a tightly closed plastic container, and allowed to stand for 24 hours to reach a minimum humidity of 75%.

The test was conducted using the CBR (California Bearing Ratio) tool. The CBR mold was prepared, the spacer dish was placed on the bottom, and the soil sample was put into the mold by filling 1/3 of the mold height for 3 layers. Pounding was done according to the different number of poundings for each sample, namely 56 poundings, 25 poundings, and 10 poundings. After that, the mold and soil samples were weighed before being inserted into the CBR test equipment [9].

The CBR test was conducted with a pressure of 7.62 cm^2 and a penetration speed of 0.64 cm/min, with penetration and pressure readings every 0.5 minutes. After the CBR test was completed, the soil sample was removed from the mold using a hydraulic jack, then dried in the oven for 24 hours and weighed to determine its dry weight. Finally, the CBR criteria for subgrade soils were classified.


Figure 3. CBR Test

Table 1. CBR Criteria (KMLH39-1996)[10]

Section	Materials	CBR Values (%)
Subgrade	Very good	20 – 30
	Good	10 – 20
	Medium	5 – 10
	Bad	< 5

RESULTS AND DISCUSSION

Density

Table 2. Density values

Descriptiom	Collision 56	Collision 25	Collision 10
Mass of test specimen + mold (g)	7340	7160	6760
Molding mass (g)	4060	4060	4060
Mass of wet specimen (g)	3280	3100	2700
Mold content (cm3)	3091	3091	3091
Wet density (g/cm3)	1.06	1.00	0.87
Dry density (g/cm3)	0.80	0.83	0.44
Dry specimen mass (g)	3020	2840	2500

Based on Table 2, the wet and dry density data show that the number of impacts has a significant influence on soil density and stability. Soil with 56 impact has excellent density, indicating high density and bearing capacity, which is important for subgrade applications in highway construction. Soils with 25 impacts also exhibit good density and are reliable for similar applications, although not as strong as soils with 56 impacts. In contrast, soils with 10 impacts show low density, indicating the need for increased compaction or stabilization before use in

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol XX No.X Month Year
http://cived.ppj.unp.ac.id/index.php/CIVED

construction applications [11].

Penetration and Calibration

Table 3. CBR Readings and Calibration

Time (minute)	Penetration (mm)	Collision 56		Collision 25		Collision 10	
		Load Dial Gauge Readings	Penetration Load (kN)	Load Dial Gauge Readings	Penetration Load (kN)	Load Dial Gauge Readings	Penetration Load (kN)
0	0	0	0	0	0	0	0
0.25	0.32	1	0.6830	5	0.6830	5	0.1365
0.5	0.64	1.5	1.3659	8	1.0927	10	0.2048
1	1.27	1.8	2.4587	11.5	1,5708	18	0.2458
1.5	1.91	2	3.2782	14.5	1.9806	24	0.2731
2	2.54	3	3.9612	16.1	2.1991	29	0.4097
3	3.81	5	4.9173	19.2	2.6226	36	0.6829
4	5.08	6	5.7369	25	3.4148	42	0.8195
6	7.62	8	7.5126	29	3.9612	55	1.0927
8	10.16	12	8.8785	29	3.9612	65	1.6391
10	12.7	14	9.5615	29	3.9612	70	1.9123

From Table 3, at a penetration of 2.54 mm, the penetration load value at impact 56 is 3.9612 kn, at impact 25 is 2.1991 kn, and at impact 10 is 0.4097 kn. Meanwhile, at a penetration of 5.08 mm, the penetration load value at impact 56 is 5.7369 kn, at impact 25 is 3.4148 kn, and at impact 10 is 0.8195 kn. This shows that the penetration load values generated from the CBR test indicate that soils with a higher number of impacts have better density, strength, and stability. Soils with 56 impacts performed best, followed by 25 impacts, and lowest at 10 impacts. This gives a clear picture of the importance of compaction in improving soil bearing capacity for highway construction applications [12].

CBR Design Value

EISSN: 2622-6774
Vol XX No.X Month Year
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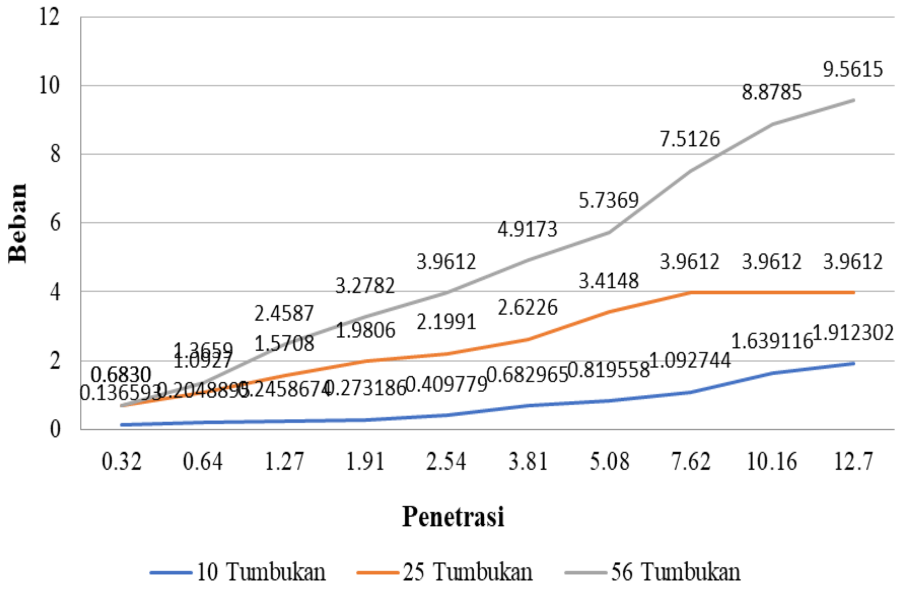

Figure 4. CBR graph

Table 4. CBR Value (%)

CBR Value (%)		
Collision 56	**Collision 25**	**Collision 10**
2.54 mm	2.54 mm	2.54 mm
$\frac{3.9612}{13.35} \times 100 = 29.672$	$\frac{2.1991}{13.35} \times 100 = 16.473$	$\frac{0.4097}{13.35} \times 100 = 3.070$
Collision 56	Collision 25	Collision 10
5.08 mm	5.08 mm	5.08 mm
$\frac{5.7369}{20.02} \times 100 = 28.660$	$\frac{3.4148}{20.02} \times 100 = 17.060$	$\frac{0.8195}{20.02} \times 100 = 4.094$

The CBR values of the three impact conditions in Figure and Table 4 show that the soil with 56 impacts has the highest CBR value of 28.660%, followed by impact 25 at 17.060%, and the lowest at impact 10 at 4.094%. This indicates that the soil with more impacts has a higher bearing capacity and is more suitable as a subgrade for road pavement [13]. Based on Table 1, the CBR values for 25 and 56 impacts are in the good (10-20%) to very good (20-30%) category, while the CBR value for impact 10 is below the medium category (5-10%).

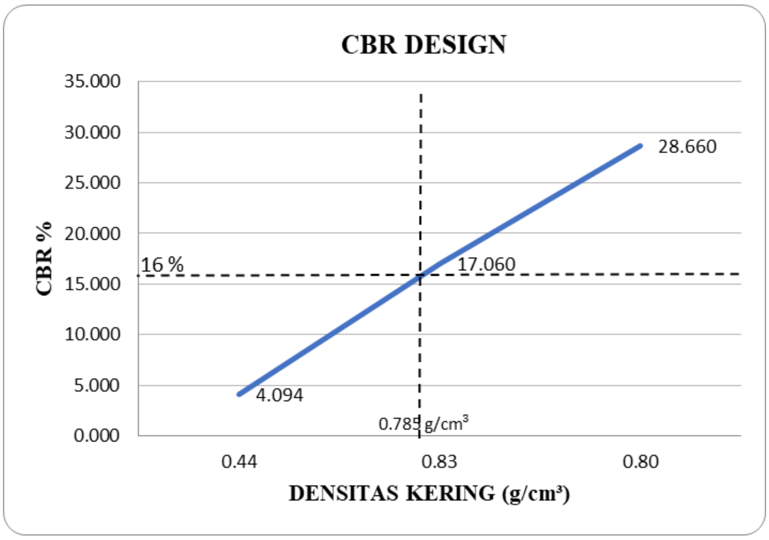

Figure 5. CBR design graph

Table 5. CBR design results

Test Method	SNI 1742:2008
Optimum Moisture Content (%)	34.93
Maximum Dry Density (g/cm)³	0.83
Design Dry Density 95% (g/cm)³	0.785
CBR Design (%)	16

Based on the figure and table 5 above, the CBR value obtained is 16%, indicating that the material has good strength and stability to withstand traffic loads when used as a subgrade layer according to the criteria in table 1.

CONCLUSION

Based on the results of density, penetration, and CBR tests, a CBR design value of 16% was obtained, indicating that the soil in that area can be used as subgrade for flexible pavement. The soil with 56 impacts showed the best performance in all tests conducted. Its high wet and dry densities indicate excellent compaction, while the high penetration load values demonstrate strength and resistance to pressure. The high CBR value further confirms that this soil has excellent bearing capacity, making it highly suitable for use as a subgrade layer in highway construction.

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