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Correlation Analysis of CBR and Sand Cone Values at the Sub Base of Simpang Tambue-Lhok Dagang Road at STA 1+050 to STA 6+450

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ABSTRACT
The rapid increase in traffic volume will lead to a lower level of road service, so that the traffic flow on the road becomes less smooth. To overcome this situation, efforts are needed, including repairing the pavement layer, one of which is the subbase layer. To determine the bearing capacity and degree of density of the subbase course, CBR field and Sand Cone tests are carried out. The purpose of this study was to analyze the relationship between the CBR value and the Sand Cone, the data were from the results of field and laboratory tests carried out by the executor, the CBR test results obtained were between 60.27% and 72.87% while the Sand Cone was between 59.88% and 62. .71% but after an average CBR and Sand Cone values become 62.48% and 60.44%. From the results of the Product Moment correlation test, a correlation value of -0.225 was obtained. This shows a negative relationship between CBR and Sand Cone values. Furthermore, from the results of the correlation coefficient significance test, it was obtained that t count = -0.730, this t count value is smaller than t table= 2.228 with degrees of freedom 12 -2 = 10 and an error rate of 5% for the 2-party test, so it can be concluded that Ho is accepted and H1 is rejected. This means that there is no significant correlation between CBR and Sand Cone values.

Keywords: *CBR, Sand Cone, and Product Moment Correlation*

1. INTRODUCTION

The rapid increase in traffic volume will lead to a lower level of road service, so that the traffic flow on the road becomes less smooth. To overcome this situation, efforts are needed, one of which is the improvement of existing roads. Jalan Simpang Tambue - Lhok Dagang is a class IIIa road which is one of the roads in Simpang Mamplam District, Bireuen Regency which serves regional relations, so it plays a very important role in regional economic growth. The Simpang Tambue - Lhok Dagang road, which is 6.5 km long with a pavement width of 4 m, with a shoulder width of around 0.75 m, is a 1-lane road. Seeing the geometric condition of the road and the level of road service to traffic is very low. It is no longer possible to maintain this situation for the foreseeable future given the ever-increasing traffic volume. Therefore efforts to improve Jalan Simpang Tambue - Lhok Dagang are the right alternative at this time.
In improving this road, the work done is to make the wear surface from asphalt latasir to hot mix asphalt. The planned pavement thickness is 40 cm, consisting of a 5 cm thick surface course, 15 cm base course and 20 cm subbase course.

2. LITERATURE REVIEW

2.1. General

The soil used as the basic material for road pavement must be able to function as a transfer of traffic loads to the subgrade without collapse and be resistant to weather influences. One way to increase the carrying capacity of the soil is stabilization. To estimate the suitable stabilization of a soil type, it is necessary to know the properties of the soil in advance.

2.2 Soil Classification

Bowles (1986), In general, soils are classified as coarse-grained and fine-grained soils. To classify land, there are two systems that are most widely used, namely the AASHTO (American Association of State Highway and Transportation Official) system and the USCS (Unified Soil Classification System). Soils classified according to the AASHTO classification system, are generally divided into two main groups. The first group is based on the grain size that passes sieve number 200 which is 35% smaller than the total weight of the soil mass. This group includes coarse-grained materials, which consist of groups A-1, A-2 and A-3. The second group is fine-grained material, that is, if more than 35% of the grains pass through sieve number 200. In general, this group consists of silt and clay consisting of groups A4, A-5, A-6 and A-7. Apart from being based on the fraction of grains that pass sieve number 200, this material still incorporates soil classification with the index liquid plastic limit.

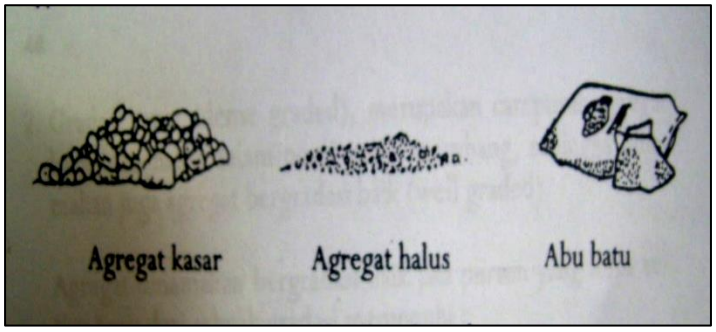
2.3 Pavement Construction

The pavement layer is a construction above the subgrade which functions to carry the traffic load by providing a sense of security and comfort. Road pavement construction is divided into two groups according to the binding material used, namely flexible pavement and rigid pavement. flexible pavement (flexible pavement) is made of aggregate and binder asphalt.
Rigid pavement layers are made of aggregate and cement binding materials, consisting of a single layer of concrete slabs with or without a subbase between the pavement and the subgrade.
According to Bina Marga, road construction consists of:

1. Layer the surface (Surface Course).
2. Upper Foundation Layer (Base Course)
3. Layer of the Lower Foundation (Subbase Course)
4. Subgrade (Subgrade)

2.4 Aggregate

Aggregate/rock is defined in general as a formation of crust that is hard and malleable (solid). ASTM (1974) defines rock as a material consisting of solid minerals, in the form of large masses or in the form of fragments.
Aggregate/rock is the main component of the road pavement layer, which contains 90-95% aggregate based on weight percentage or 75-85% aggregate based on volume percentage. Thus the carrying capacity, durability and quality of the road pavement are also determined from the properties of the aggregate and the resulting mixture of aggregate with other materials.



Picture. 2.4.1 Aggregate type by size
Source: Silvia Sukirman (1992)

2.5 Compaction Theory

The purpose of compaction is to arrange the locations of the soil grains in order to achieve a tight position so as to reduce permeability and increase the carrying capacity of the soil, while the purpose of compaction is compaction which is carried out by providing a dynamic load/load to the soil mass.
Wesley (1977), the mechanical method used to compact the soil may vary. In the field, the grinding method is usually used, while in the laboratory the hitting method is used. For each certain compactive effort, the density achieved depends on the amount of water in the soil, i.e. on its water content.

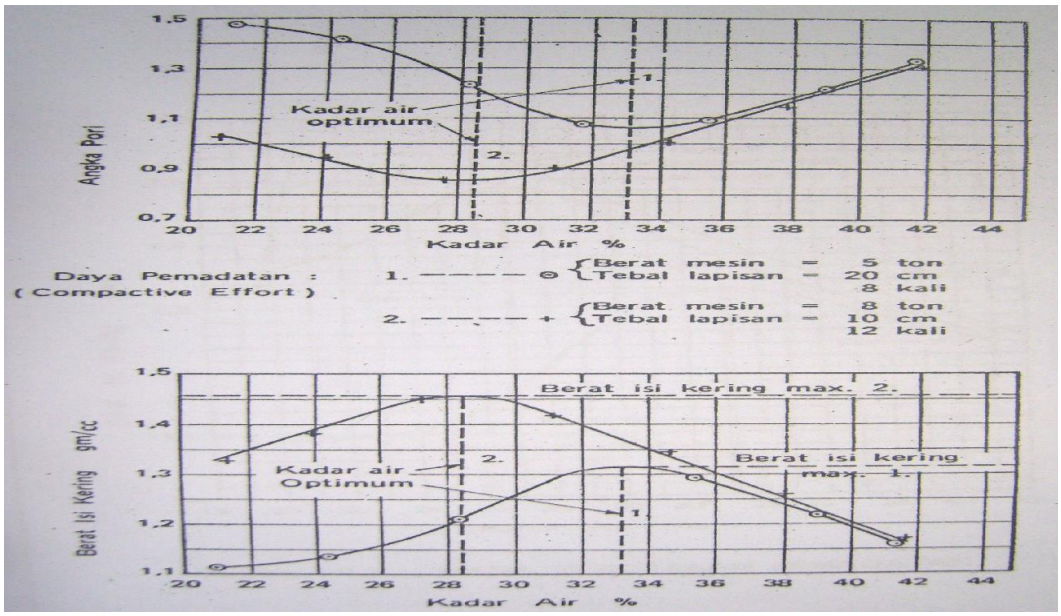


Figure : 2.5.1 Effect of water content and soil compaction power
Source: Wesley, (1977)

2.6 CBR (California Bearing Ratio) Analysis

There are 2 kinds of CBR measurements, namely:
1. CBR value for emphasis on penetration of 0.254 cm (0.1") against standard penetration which is 70.37 kg/cm² (1000 psi)

$$\text{CBR Value} = \frac{PI}{70{,}37} X 100 \quad \% \quad \text{.....(2.2)}$$

2. CBR value for pressure at penetration of 0.508 cm (0.2") against standard pressure which is 105.56 kg/cm² (1500 psi)

CBR value = % .....(2.3)

CBR is a method used to express the quality of each material for pavement construction against the standard material quality in the form of crushed stone which is considered to have a CBR value of 100%.

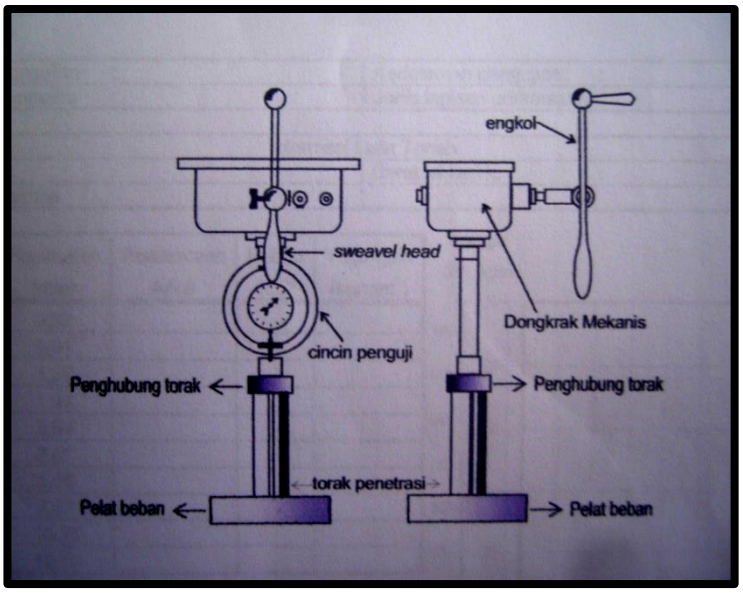


Figure 2.6.1 – Typical CBR testing equipment in the field

According to Bina Marga (1974), the way to determine the average CBR value on a roadside is as follows:

a. The lowest CBR price is determined,
b. Determine how many CBR values are the same and greater than each CBR value,
c. The highest number is expressed as 100%. Any other amount is a percentage of 100 %,
d. Graph the relationship between the price of CBR and the percentage of the amount above,
e. The segment CBR value is the value obtained from a percentage of 90%.

2.7 Sand Cone Analysis

To determine the density of various types of materials to be used in road construction activities, the Sand Cone method is often used. Sand cone is one of the tools to determine the density in place of a layer of compacted soil or pavement, the results are obtained after samples of material that can be found in the field are processed in the laboratory. This test method covers the requirements and conditions for testing soils having particles not larger than 5 cm. The purpose of this method is to obtain field density (γd).

2.8 Correlation of Moment Products

Product moment correlation is carried out to determine the level of relationship between the CBR value and the Sand Cone value. Correlation is a statistical term that states the degree of linear (unidirectional, not reciprocal) relationship between two or more variables.

3. RESEARCH METHOD

The location of this research is the connecting road Simpang Tambue – Lhok Dagang Sta. 1+050 to 6+450 Simpang Mamplam District, Bireuen Regency, to be exact 30 km from the District Capital, direction B. Aceh and the data collected is secondary data in the form of CBR data and Sand Cone data obtained from the Bireuen District Kimpraswil Office and also supporting data others which include provincial maps, regional maps and location maps. The method used is as in the flowchart below.

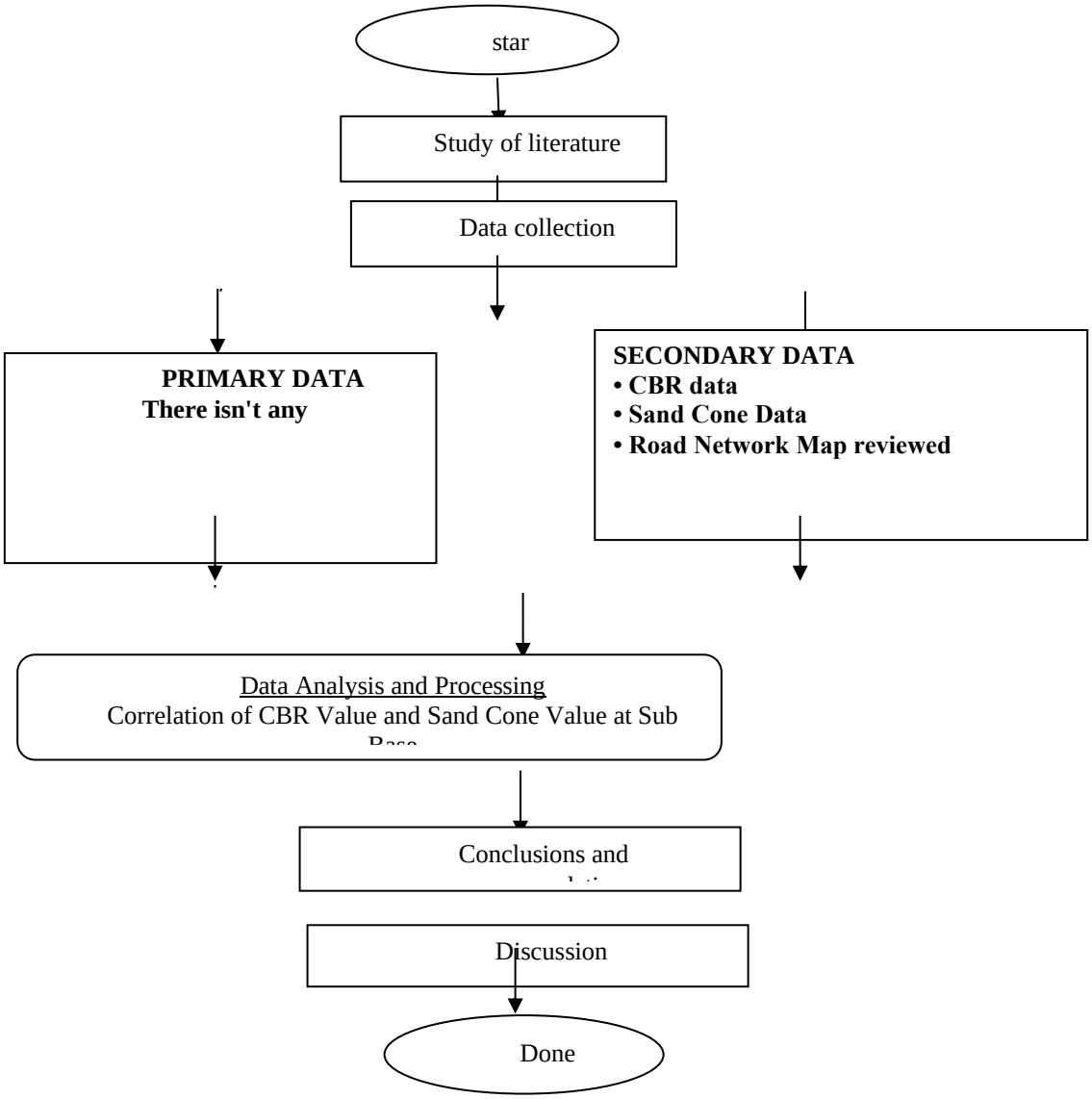


Figure 3.3 Research Flowchart

4. RESULTS AND DISCUSSION

4.1 CBR Value (California Bearing Ratio)

Checking the CBR value is preceded by testing the density, to determine the actual bearing capacity of the subbase course in the field, it is necessary to check the field CBR value. Simpang Tambue - Lhok Dagang Road with a length of 6.5 km, field CBR value checks were carried out on Sta.1+050 s/d 6+450 with a total of 28 points and the distance between the first checkpoint to the second checkpoint. For more clarity, the results of the examination of the CBR value of the field on the subbase course Jalan Simpang Tambue - Lhok Dagang.

In determining the average CBR value, the method according to Bina Marga (1974) is used as described in article 2.6, and can be seen in the graph of the relationship between the CBR value and Sand Cone, the average CBR value for the bottom layer of Simpang Tambue - Lhok Dagang Road obtained by 62.48%.

4.2 Grades of Sand Cones

Checking the value of Sand Cone is preceded by testing the density, the results of laboratory tests show that the maximum dry density (lab) is 2,081 gr/cm3. In these circumstances obtained an average degree of density of 100.73% of the required.

As stated above, that the maximum Sand Cone value is achieved when the material is in a solid state. From the results of laboratory tests on the composition of the sub base course material used in the field. The average density

degree value is 100.73% or 60.44%. The Sand Cone price meets the requirements set by Bina Marga for the Subbase Course on Class B Provincial Road Improvement, namely 60%.

4.3 Relationship between Density and Moisture Content

The figure obtained from the Atteberg limit will indicate the extent to which the material is affected by the presence of water. From the test results in the laboratory a water content of 6.1% produces a degree of density of 100.4% and there is also a water content of 6.4% which produces a degree of density of 99.8%, so from these data it shows that with a high water content it does not necessarily produce a high degree of density, as well as low water content does not necessarily result in a low degree of density either. From the inspection results, not all points have the same water content and degree of density, the water content used during compaction is greatly affected by the density.

4.4 Relationship between CBR Value and Sand Cone Value

From the value of each test, it shows that the CBR value is greater than the Sand Cone value. there are 4 (four) points of value below the required. But after the average value also meets the requirements, the CBR value and the Sand Cone value are declared to be able to meet the required conditional value. From the CBR value and Sand Cone Value, Product Moment Correlation Testing can also be carried out, but in this case the test is carried out on 12 test points as shown in table 4.4 below:

Table 4.4 Calculation of CBR and Sand Cone Values

Number	Stationing.	Mark CBR (X)	Mark Sand Cone (Y)	XY	X^2	Y^2
1	1+050	61.53	60.24	3706.57	3785.94	3628.86
2	1+450	60.69	59.88	3634.12	3683.28	3585.61
3	2+050	60.69	60.36	3663.25	3683.28	3643.33
4	2+450	60.48	60.00	3628.80	3657.83	3600.00
5	3+050	60.27	60.72	3659.59	3632.47	3686.92
6	3+450	64.89	60.84	3947.91	4210.71	3701.51
7	4+050	60.69	61.00	3702.21	3683.28	3721.23
8	4+450	62.37	60.37	3765.28	3890.02	3644.54
9	5+050	60.48	60.12	3636.06	3657.83	3614.41
10	5+450	60.69	60.24	3655.97	3683.28	3628.86
11	6+050	64.89	60.24	3908.97	4210.71	3628.86
12	6+450	72.87	59.88	4363.46	5310.04	3585.61
		$\sum X$ = 750.54	$\sum Y$ = 723.89	$\sum XY$ = 45272.17	$\sum X^2$ = 47088.66	$\sum Y^2$ = 43669.74

$$rxy = \frac{n\sum xy - (\sum x \sum y)}{\sqrt{(n\sum x^2 - (\sum x)^2).(n\sum y^2 - (\sum y)^2)}}$$

$$rxy = \frac{12x45272{,}17 - (750{,}54x723{,}89)}{\sqrt{(12x47088{,}66 - (750{,}54)^2)x(12x43669{,}74 - (723{,}89)^2)}}$$

$$rxy = \frac{543266{,}04 - 543308{,}40}{\sqrt{(56563{,}92 - 563310{,}29)x(524036{,}88 - 524016{,}73)}}$$

$$rxy = \frac{-42{,}36}{\sqrt{(1753{,}63)x(20{,}15)}}$$

$$rxy = \frac{-42,36}{\sqrt{35331,93}}$$

$$rxy = -0,225$$

from the results of testing the correlation to the average value between CBR and Sand Cone obtained a correlation value of -0.225. Based on table 2.8.1 the correlation coefficient shows the degree of negative relationship between CBR and Sand Cone values.
Furthermore, looking at the level of significance of the relationship between the two variables is obtained by calculating the test as follows.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$t = \frac{-0,225\sqrt{12-2}}{\sqrt{1-(-0,225)^2}}$$

$$t = \frac{-0,225\sqrt{10}}{\sqrt{1-0,051}}$$

$$t = \frac{-0,225x3,16}{\sqrt{0,949}}$$

$$t = \frac{-0,712}{0,974}$$

$$t = -0,730$$

If you consult the t table with dk (n-2) = 10, at α = 0.05, you get a t table of 2.228, so the t count is smaller than the t table (- 0.730 <2.228). So it can be concluded that Ho is accepted H1 is rejected.
Research that shows a significant correlation needs to be sought for the magnitude of the contribution of variable X to variable Y. To see the magnitude of the contribution of variable X to variable Y, the following formula can be used:

KD = r^2 x 100%

In this case the value of r is -0.225 so that the contribution of variable X to variable Y is as follows:
KD = r^2 x 100%
KD = $(-0,225)^2$ x 100%
KD = 0,051 x 100%
KD = 0,051 x 100%
KD = 5,1 %

Based on the results of calculating the value of the Coefficient of Determination, the value of the contribution of variable X to Y is 5.1%. The value of 5.1% indicates that the CBR gives a very small contribution value of 5.1% to the Sand Cone, and the remaining 94.9% indicates that there are other variables that influence.

5. CONCLUSION

The carrying capacity and degree of density of the Sub Base Course meet the required specifications, this is indicated by the achievement of an average CBR value and an average Sand Cone value of 62.45% and 60.44%, due to the specifications required according to Highways for Sub Base Course Class B Provincial Road Improvement is 60 %.
The higher the density value, the higher the soil carrying capacity value obtained, this is when the sub grade is really dense. From the results of the correlation test on the average value between CBR and Sand Cone, a correlation value of -0.225 is obtained.This shows the degree of negative relationship between CBR and Sand Cone values

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