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WORD COUNT 3861

TIME SUBMITTED 11-DEC-2021 10:39PM

PAPER ID 80127061

Ukarst : Universitas Kadiri Riset Teknik Sipil
Volume xx Number x Year xxxx

ISSN (Online) 2581-0855
ISSN (Print) 2579-4620

Available online at
http://ojs.unik-kediri.ac.id/index.php/ukarst/index

http://dx.doi.org/10.30737/ukarst.v3i2

Easy Way To Determine The Feasibility Of Coarse Aggregate On All Pavement Layers Using The Los Angeles Tatonas TA-700 Machine

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ARTICLE INFO

Article History :
Article entry :
Article revised :
Article received :

Keywords :
Abrasion, Coarse Aggregate, Los Angeles Machine, Road Pavement.

IEEE Style in citing this article :
[12]
M. Asadi, A. TaghaviGhalesari, and S. Kumar, "Machine learning techniques for estimation of Los Angeles abrasion value of rock aggregates," Eur. J. Environ. Civ. Eng., vol. 0, no. 0, pp. 1–14, 2019, doi:10.1080/19648189.2019.1690585

ABSTRACT

The coarse aggregate in the asphalt mixture is responsible for carrying the load imposed by the traffic on it. The use of coarse aggregate with poor quality can cause bumpy roads, cracked roads, potholes, and others. Because of this, the coarse aggregate used in the pavement layer must be of good quality. There are several parameters that are used as a benchmark for the feasibility of coarse aggregate including adhesion to asphalt, flatness index, water absorption, specific gravity, and wear. Coarse aggregate wear is an indicator of the aggregate resistance index against friction with other objects. Any aggregate to be used in a pavement mix must meet the wear requirements. The purpose of this study is to determine the feasibility of coarse aggregate in Kedak Village, Kediri. This research was conducted by using an abrasion test using the Los Angeles TA-700 machine and SNI 2417:2008 as a reference. The specimens were taken at random and met the criteria for passing the number 3/4 sieve and stuck on the 2500 gram sieve number 1/2 and the aggregate that passed the 1/2 sieve was stuck on the 3/8 sieve as much as 2500 grams. The results obtained stated that the average wear of the abrasion test was 26.6%. From these results, the coarse aggregate from Kedak Village, Kediri can be declared feasible for all mixtures of road pavement layers.

1. Introduction

Kedak Village is one of the villages in Kediri City. This village is famous as a producer of coral or crushed stone. One of the uses of coral or crushed stone is to use it as aggregate in a mixture of road pavement layers. Aggregates are the dominant material in the manufacture of construction materials such as road pavements [1]. In general, a mixture of pavement layers is a combination of approximately 95% of aggregate (coarse and fine aggregate) which is bonded together by an asphalt binder [2]. Fine aggregate consists of particles of natural sand or fine

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ISSN (*Print*) 2502-9304

crushed stone that pass the No. 4 (4.75mm) sieve. Meanwhile, coarse aggregate consists of crushed stone or crushed gravel retained on a No. sieve. 4 (4.75mm) which is clean, dry, strong, and free from other irritating materials [3]. The coarse aggregate in the asphalt mixture is responsible for carrying the load imposed by the traffic on it.

The use of coarse aggregate with poor quality can cause bumpy roads, cracked roads, potholes, and roads can not last long [4]. Because of this, the coarse aggregate used in the pavement layer must be of good quality. The quality of the aggregate in the asphalt mixture is strongly influenced by the characteristics of the aggregate particles such as grain shape, grain size, angularity, texture and morphological characteristics [5][6]. There are several parameters that are used as a benchmark for the feasibility of coarse aggregate including adhesion to asphalt, flatness index, water absorption, specific gravity, and wear [7]. Coarse aggregate wear is an indicator of the aggregate resistance index against friction with other objects. Any aggregate to be used in a pavement mix must meet the wear requirements.

Several studies regarding the observation of aggregate wear using the Los Angeles machine show that aggregate wear affects the quality of aggregate resistance [8][9]. However, there is still no aggregate feasibility study using samples from Kedak Village, Kediri.

The purpose of this study is to determine the feasibility of coarse aggregate in Kedak Village, Kediri. This research was conducted using a Los Angeles TA-700 engine with reference to SNI 2417-2008 [10]. The specimens were taken at random and met the criteria for passing the number 3/4 sieve and stuck on the 2500 gram sieve number 1/2 and the aggregate that passed the 1/2 sieve was stuck on the 3/8 sieve as much as 2500 grams. From this research, it will be known the wear value of coarse aggregate originating from Kedak Village, Kediri. So, by knowing the feasibility results, it can be used as a reference for the mixture of road pavement layers.

2. Research Method

The method used in this study is an experimental method directly on a predetermined object. This research was conducted at the Civil Engineering Laboratory, University of Kadiri.

2.1 Material

The material used in this research is coarse aggregate as a test object and water as an object that helps clean the aggregate from dust and dirt.

2.1.1 Coarse Aggregate

In this study using coarse aggregate in the form of coral originating from the Kedak area, Kediri. The size of the coarse aggregate used is the aggregate that passes the sieve no. 3/4 retained sieve no. 1/2, and the aggregate passes sieve no. 1/2 retained sieve no. 3/8 [11].

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ISSN (*Print*) 2502-9304

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Figure 1. Coarse Aggregate.

2.1.2 Water

In this study, clean water was used to wash aggregates before abrasion testing. This water comes from the Civil Engineering Laboratory of Kadiri University.

Source: Personal Documentation

Figure 2. Water.

2.2 Tool

2.2.1 Los Angeles Tatonas Abrasion Machine TA-700

The engine consists of steel cylinders enclosed on both sides with an inner diameter of 711 mm (28 inches) and an inner length of 508 mm (20 inches). The cylinder rests on two short, discontinuous shafts and rotates on a horizontal axis. Perforated cylinder for inserting the test object. The manhole cover is securely fastened so that the inner surface of the cylinder is not disturbed. Inside the cylinder is a full 89 mm (3.5 inch) cross-section steel blade [12].

Source: Personal Documentation

Figure 3. Los Angeles Tatonas Abrasion Machine TA-700.

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The Los Angeles Machine is equipped with several other equipment as follows.

- Steel Ball

  The steel balls used in this study had an average diameter of 4.68 cm (1 27/32 inches) and weighed between 390 grams and 445 grams each [4].

Source: Personal Documentation

Figure 4. Steel Balls.

- Pan

  The baking sheet used in this study has a square shape with a length and width of 65 cm. This pan is used to accommodate the results of aggregate testing after abrasion tests have been carried out using a Los Angeles machine.

Source: Personal Documentation

Figure 5. Pan.

2.2.2 Sieve

In this study, sieve numbers 3/4 , 1/2, 3/8 were used to prepare aggregates before the Abrasion test was carried out. And sieve number 12 is used to sieve the aggregate after the abrasion test is carried out [13].

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Figure 6. Sieve Number 3/4 , 1/2, 3/8, and 12.

2.2.3 Sieve Shaker Tatonas TA-517

Sieve Shaker is a tool used to separate aggregates with different grain sizes [14]. Sieve Shaker is used to sieve the aggregate to be used for abrasion testing.

Source: Personal Documentation

Figure 7. Sieve Shaker.

2.2.4 Balance

The scales used have an accuracy of 0.1% of the sample weight or 5 grams [15].

Source: Personal Documentation

Figure 8. Balance.

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First Author/ Ukarst vol (no) year
ISSN (*Print*) 2502-9304

2.2.5 Oven

The oven used has a temperature control to heat up to 110°C ± 5°C [16].

Source: Personal Documentation

Figure 9. Oven.

2.3 Test Execution

The implementation of the abrasion test is carried out as follows.

1. The aggregate to be tested is prepared by taking it randomly from Kedak Village, Kediri for abrasion testing [17].

Source: Personal Documentation

Figure 10. Random Aggregate Picking.

2. Wash the aggregate sample using clean water until there is no dust or mud adhering [18].

Source: Personal Documentation

Figure 11. Aggregate Wash.

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3. Dry the aggregate sample using an oven at a temperature of 110 °C ± 5 °C for 24 hours [19].

Source: Personal Documentation

Figure 12. Aggregate Drying.

4. Aggregate was sieved using a sieve shaker, with sieves numbered 3/4, 1/2, and 3/8 arranged by sieve from the largest to the smallest diameter.

Source: Personal Documentation

Figure 13. Aggregate Sifting.

5. Take the aggregate that is stuck in sieves number 1/2 and 3/8 then weigh 2500 grams each 2 times [20].

Source: Personal Documentation

Figure 14. Aggregate Weighing.

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6. Mix the suspended aggregate in sieves number 1/2 and 3/8 that have been weighed until evenly mixed.

Source: Personal Documentation

Figure 15. Aggregate Mixer.

7. Load the aggregate after weighing into the Los Angeles machine.

Source: Personal Documentation

Figure 16. Aggregate Loaded into Los Angeles Machine

8. Load 12 steel balls into the Los Angeles machine [21].

Source: Personal Documentation

Figure 17. Steel Ball Loaded into Los Angeles Machine.

9. Set the Los Angeles engine to 500 revolutions then start it [22].

Source: Personal Documentation

Figure 18. Setting the Los Angeles Machine 500 revolutions.

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Volume xx Number x Year xxxx
ISSN (*Online*) 2581-2157
ISSN (*Print*) 2502-9304

10. After the Los Angeles engine reaches 500 revolutions and stops, remove the aggregate sample along with the steel ball and pour it into the tin.

Source: Personal Documentation

Figure 19. Aggregate Removed from Los Angeles Machine.

11. Sift the aggregate sample from the abrasion test using sieve number 12 [23].

Source: Personal Documentation

Figure 20. Aggregate Sifting After Abrasion Test.

12. Wash the aggregate retained on the number 12 sieve using clean water until there is no dust and mud adhering to it.

Source: Personal Documentation

Figure 21. Aggregate Wash.

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ISSN (*Print*) 2502-9304

13. Dry the aggregate using an oven at a temperature of 110°C ± 5°C for 24 hours.

Source: Personal Documentation

Figure 22. Aggregate Drying.

14. Weigh the abraded aggregate after drying in the oven.

Source: Personal Documentation

Figure 23. Aggregate Weighing After Abrasion Test

Source: Personal Documentation

Figure 24. Aggregate After Abrasion Test

2.4 Aggregate Wear

Aggregate wear in terms of aggregate resistance to friction with other objects [24]. The calculation of aggregate wear is as follows.

$$\text{Wear} = \frac{a-b}{a}\ x\ 100\%$$

With Description:

a = Test Object Weight (grams)

b = Weight of Retained Test Object Sieve No. 12 (1.7 mm) after the test object is inserted Los Angeles machine (grams)

The provisions for the aggregate wear value according to the General Specifications of the 2018 Binamarga Division 6 [25] can be seen in the following table.

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Table 1. Coarse Aggregate Wear Condition

Test			Test Method	Value
Abrasion with Los Angeles Machines	Mix of Modified AC and SMA	100 Revolutions	SNI 2417:2008	Maks. 6%
		500 Revolutions		Maks. 30%
	All kinds of other graded asphalt mix	100 Revolutions		Maks. 8%
		500 Revolutions		Maks. 40%

Source: General Specifications of Binamrga 2018

This study was used for all types of asphalt mixtures and used a Los Angeles engine with 500 revolutions. Therefore, the wear yield of coarse aggregate should not exceed 40%.

3. Results and Discussions

From the abrasion test carried out, the following results were obtained.

Source: Personal Documentation

Figure 25. Sample Abrasion Test Results 1

Source: Personal Documentation

Figure 26. Sample Details Aggregate 1

Based on **Figure 25.** it can be seen that the weight of the aggregate retained on sieve number 12 after the abrasion test was carried out on sample 1, the result was 3775 grams.

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Source: Personal Documentation

Figure 27. Sample Abrasion Test Results 2

Source: Personal Documentation

Figure 28. Sample Details Aggregate 2

Based on **Figure 27.** it can be seen that the weight of the aggregate retained on sieve number 12 after the abrasion test was carried out on sample 2, the result was 3565 grams. From these results can be presented in the form of a table as follows.

Table 1. Abrasion Test Results Samples 1 and 2

Gradation Inspection		**Number of Spins = 500 Revolutions**	
Sieve Size		**Sample 1**	**Sample 2**
Slip	**Stuck**	**Weight (a)**	**Weight (a)**
76,2 (3")	63,5 (2,5")		
63,5 (2,5")	50,8 (2")		
50,8 (2")	36,1 (1,5")		
36,1 (1,5")	25,4 (1")		
25,4 (1")	19,1 (3/4")		
19,1 (3/4")	12,7 (1,5")	2500	2500
12,7 (1,5")	9,52 (3/8")	2500	2500
9,52 (3/8")	6,35 (1/4")		
6,35 (1/4")	4,75 (No.4)		
4,75 (No.4)	2,36 (No. 8)		
Total Weight		5000	5000
Retained weight of filter No. 12 after trial (b)		3775	3565

Source: Research Results

Based on the table above, it can be seen that the aggregate weight of sample 1 and sample 2 before the abrasion test was carried out was 5000 grams. As well as the retained weight of sieve number 12 after the abrasion test was carried out on sample 1, the results were 3775

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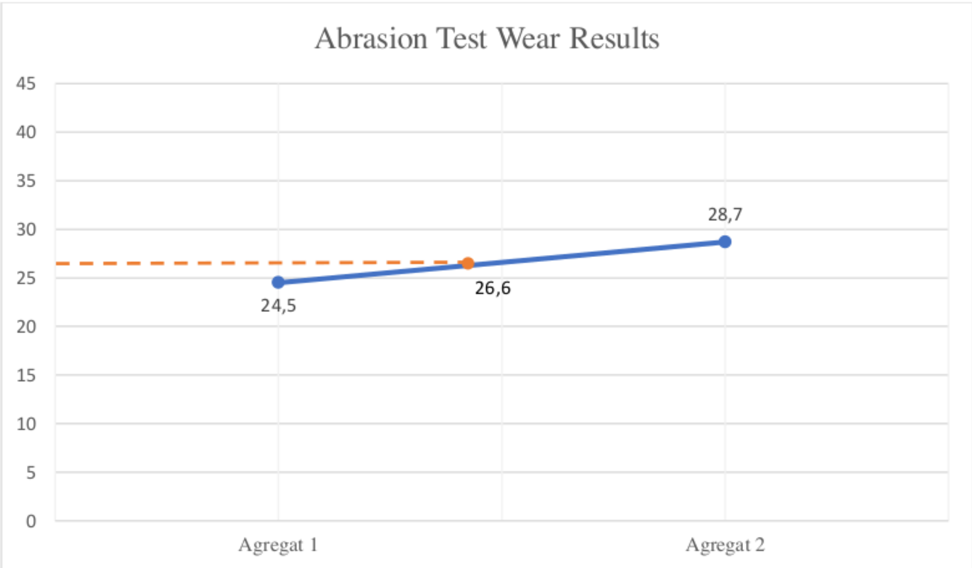
grams and in sample 2 of 3565 grams. From these data, it can be calculated the aggregate wear as follows.

Aggregate 1 = $\frac{5000-3775}{5000}$ x 100% = 24,5%

Aggregate 2 = $\frac{5000-3565}{5000}$ x 100% = 28,7%

From the results of the calculation of aggregate wear, it is stated that in sample 1 it is 24.5% and in sample 2 it is 28.7%. Furthermore, the average wear of the aggregate can be calculated as follows.

Average Wear = $\frac{24,5 + 28,7}{2}$ = 26,6%



Source: Research Results

Figure 29. Abrasion Test Wear Results

From the calculation of the average wear and tear obtained a value of 26.6%. According to the 2018 Binamarga General Specifications, division 6 states that the aggregate to be used for asphalt mixtures must not exceed 40%. So based on the results of the abrasion test, it can be concluded that the aggregate is declared feasible for asphalt mixture materials.

4. Conclusion

Based on the research that has been done, the average wear result of the abrasion test is 26.6%. So that the aggregate can be declared feasible for all road pavement mix materials.

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