PERFORMANCE ANALYSIS OF PORUS ASPHALT MIXTURE USING ANTI-PELALING AGENTS WITH REAM SPECIFICATIONS

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ABSTRACT

Flexible pavement is very weak against waterlogging because water can loosen the bond between aggregate and asphalt. Porous Asphalt has lower durability because it has high pores so that it can be passed by water. Poor bonding of asphalt and aggregate will cause stripping. This peeling can cause water absorption which will eventually accelerate road damage. Derbo 401 anti-peeling material is one of the new breakthroughs, in the form of additives that can change the properties of aggregates and asphalt, increase adhesion and bonding, and reduce the negative effects caused by water so as to produce a mixture of asphalt with high adhesion. The purpose of this study was to determine the effect of adding anti-stripping agent type Derbo-401 to the permeability value and to determine the resistance of the porous asphalt mixture with the addition of anti-striping agent type Derbo-401 in the Cantabro test and to determine the microstructure of the porous asphalt mixture. Using the REAM-2008 Specification. Based on the results of the study, the Permeability Coefficient Value of the porous asphalt mixture was 0.254 cm^3/sec. the lowest percentage Derbo 0.4%, the lowest Cantabro Loss value at 0.3% addition percentage gets an average value of 6.13%, Has met the required specifications max 15%. The elements that make up the porous asphalt mixture with the addition of Derbo percentage are more in the elements Si (silicon) 19.93%, Ca (calcium) 21.12%, S (sulfur) 8.45%, Fe (ferrum) 8.80%, K (potassium) 2.42% and the other elements are less.

Keywords: anti striping agent; Derbo-401; cantabro loss; permeability; porous asphalt; REAM-2008.

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INTRODUCTION

One of the pavement technologies currently being developed is Porous Asphalt. Porous Asphalt has lower durability because it has high pores so that it can be passed by water. Poor bonding of asphalt and aggregate will cause stripping. This peeling can cause water absorption which will eventually accelerate road damage. (Djumari & Djoko Sarwono 2009). Derbo 401 anti-peeling material is one of the new breakthroughs, in the form of additives that can change the properties of aggregates and asphalt, increase adhesion and bonding, and reduce the negative effects caused by water so as to produce a mixture of asphalt with high adhesion. Anti-peeling material is composed of amino polymers that are insoluble in water but only soluble in oil and the concentration is very small when used in asphalt mixtures so that it is not a B3 waste (Toxic and Hazardous Materials) and also does not pollute the surrounding water sources so it is safe for humans. environment.

The addition of Derbo 401 as an anti-peeling agent in asphalt mixtures has also been studied by Theresia Marisa Prima Simatupang (2015) Derbo 401 is added to the AC-WC mixture. Good effect on the mixture is indicated by all test results meet the specifications. A similar study was also conducted by Matris Derianza Hafidz et al (2016), using anti-peeling materials. The functional performance of the porous asphalt mixture is also getting better with the permeability coefficient increasing and disintegration getting better along with the increase in anti-stripping wetfix be levels, as evidenced by the decrease in the Cantabro Loss value.

Porous asphalt is an asphalt mixture that is being developed for wearing course construction. This layer uses an open graded layer that is spread over a waterproof asphalt layer. The mixture is dominated by coarse aggregate, to obtain pores high enough to obtain high permeability of porous asphalt, where permeability is used for subsurface drain. (Tjaronge, 2013). Porous asphalt has

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properties that can drain water and function as drainage so that rainwater is not accommodated on the surface which can cause aquaplaning which endangers the lives of road users. Besides that, the porous asphalt uses mostly coarse aggregate material, which is about 85%, which causes the surface to be rough and has a high skid resistance so that the vehicle does not slip easily and the large cavity in it causes the porous asphalt to absorb the noise due to the presence of porous asphalt. friction between vehicle tires and the road surface. (Ali, 2011). The gradation used in this study is the gradation using REAM. The provisions for the REAM gradation can be seen in the table 1 below.

Table 1. Aggregate gradation of Road Engineering Association of Malaysia (REAM 2008) specifications

No. Sieve	Sieve Size (mm)	Percentage of Aggregate Passing (%)	
		Grad A	Grad B
¾	20.0		100
½	14.0	100	85 – 100
3/8	10.0	95 – 100	55 – 75
4	5.0	30 – 50	10 – 25
8	2.36	5 – 15	5 – 10
200	0.075	2 – 5	2 – 4

Source: Road Engineering Association Of Malaysia (REAM, 2008)

Table 2. Conditions for Asphalt Mixture Road Engineering Association of Malaysia (REAM 2008)

No.	Planning Criteria	Value
1.	Cantabro Loss Test (%)	Maks. 15
2.	Flow test (cm3/s)	Maks. 0,3
3.	Content of voids in the mixture (VIM %)	18 – 25
5.	Marshall Stability (kg)	Min. 350
6.	Marshall Melt (mm)	2 – 4
7.	Marshall quotient (kg/mm)	Min. 200
8.	Number of collisions per plane	50

Source: Road Engineering Association Of Malaysia (REAM, 2008)

In this research, the Anti Stripping Agent used is in liquid form with the brand Derbo 401. It is included in the Fatty Polyamines group. The dosage for Derbo 401 ranges from 0.1-0.4% for hot mix asphalt, and 0.2-0.5% for road repairs (Source: https://www.petrochemspecialities.com,2021). This microstructure test was carried out X-Ray Fluorescence (XRF) is a method to be able to analyze the elemental composition in a sample quickly. The principle used is the determination of the elemental composition based on the interaction of X-rays with matter. Samples analyzed can be in the form of powder or lumps, weighing at least 5 grams. Detected elements: Pb, Zn, Fe, Cu, Ni, Ti, Ca, Mo, Zr, Sr, Rb, Se, As, Au, W, Co, Cr, V, Sb, Sn, Cd, Ag, Pd, Nb, Bi, Th, U, Hg, Sc, K, S, Ba, Cs, Te and Undetectable elements: Si, Al, Mg, Na. Bowles (1984) states that any material that has a cavity is called a pore, and if the cavities are interconnected, the material will have permeability properties. Verhoef (1989) defines that permeability is the ability of a liquid to penetrate the cavities possessed by materials that are in contact with one another. determine the resistance of the test object to wear using the Los Angeles machine. The test object which is allowed to stand for 48 hours at room temperature and at least 6 (six) hours before the temperature test must be kept at room temperature. Before the test object is inserted into the Los Angeles machine drum, it is first weighed to get the weight before abrasion (Mo), then the test object is inserted into the Los Angeles machine drum without steel balls. The Los Angeles engine is then run at speeds between 30-33 rpm for 300 revolutions. After completion of the test object is removed and weighed with the weight after abrasion (Mi).

In addition to the mixture for asphalt used a balanced composition. This balanced composition aims that the asphalt mixture will be strong and always in a clear concept according to SNI. Mixing asphalt and concrete aims to make the road surface stronger. This surface layer is to obtain the right method to be applied in every research. A layer of asphalt and concrete with a uniform shape will

be stronger if used according to clear rules and concepts (Putranto FR, Syaiful S, 2019; Mubarak M, et.al, 2020; Syaiful S, Lasmana L, 2020; Syaiful S, 2020; Syaiful S, 2021; Triyanto T, et.al, 2020).

RESEARCH METHODS

In this study, the method used is quantitative, namely the research method based on testing a theory consisting of variables, measured by numbers, and analyzed by statistical procedures to determine whether the theory is correct. carried out at the Civil Engineering Laboratory, Fajar Makassar University, Jl. Prof. Abdurrahman Basalamah (Ex. Racing Centre) No. 101, Karampuang, Panakkukang Makassar City, South Sulawesi 90231, Indonesia. By using asphalt mixing test with anti-peeling material, so as to get the observation results needed as a method of data collection and data processing.

The research procedure in the first stage is preparation starting with the collection of data obtained from the results of previous tests that have been carried out by previous researchers, both from published journals and data from books and data from government agencies in this case the Ministry of Public Works. Then the stage of preparing tools and materials, taking the materials to be used, transporting research materials from the location of material collection to the laboratory. To find out the characteristics of each material that will be used for hollow asphalt mixtures. To ensure that the material meets the standards of the specifications used, namely the Indonesian National Standard (SNI), and the Road Engineering Association Of Malaysia (REAM 2008). Sampling method as follows:

The research in the form of coarse aggregate and fine aggregate was obtained from a stone crusher (stone crusher) which was taken from Bili-Bili District, Parangloe District, Gowa Regency, South Sulawesi Province. PEN 60/70 oil asphalt was taken from the Civil Engineering Laboratory, Fajar University, Makassar. Derbo 401 was obtained from PT. Alfindo Perkasa.

Making the test object using the following steps:

a. Prepare the aggregate in accordance with the composition of the mixture that has been determined.

b. Aggregate is heated to a temperature of ± 150°C

c. After reaching that temperature, mix the aggregate with oil asphalt along with the addition of anti-peeling Derbo 401 (0.1%, 0.2%, 0.3% and 0.4%)

d. The mixture was compacted at a temperature of ± 120°C, with 2 x 50 collisions for REAM specifications. The tests to be carried out are hollow asphalt which includes the composition of the porous asphalt mixture and the testing of hollow asphalt specimens. After testing the materials and meeting the specifications for the manufacture of test objects, the composition of the mixture that will be used in this study is an open graded mixture composition which will refer to the provisions of the hollow asphalt mixture grading Road Engineering Association Of Malaysia (REAM 2008).

Table 3. Number of Test Objects

Anti-peeling levels	Permeability Test	Cantabro Test
0%	3	3
0,1%	3	3
0,2%	3	3
0,3%	3	3
0,4%	3	3
Total	15	15
Total	**30**	

Source: Civil Engineering laboratory test results and calculations, UNIFA

For testing XRF (X-Ray Fluorosscence (XRF) is taken from the results of the Cantabro test which has the best test value. The test object is a mixture of porous asphalt briquettes with the addition of anti-peeling Derbo 401 (0.1%, 0.2%, 0.3). % and 0.4%) are as follows:

1. XRF (X-Ray Fluoroscence) testing.

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2. Permeability testing.

3. The cantabro test was carried out using the Los Angeles tool with reference to the Road Engineering Association Of Malaysia (REAM, 2008).

Collecting data in this study by conducting experimental activities in the laboratory. Hollow asphalt is produced using the same type of aggregate directly from the stone crusher and bitumen. Furthermore, observations were made to determine the value of weight loss in the Cantabro test. The method used in this research is laboratory research, with reference to:

a) Indonesian National Standard (SNI),

b) American Association for Testing and Materials (ASTM),

c) Road Engineering Association Of Malaysia (REAM 2008)

Data analysis In this study, the analysis of the data obtained from the test results is presented in the form of tables, images and graphs which will then be analyzed. Data analysis in this study aims to determine the effect of the addition of Derbo 401 on the value of permeability, weight loss and microstructure of the porous asphalt mixture.

RESULTS AND DISCUSSION

The physical properties of the aggregates can be known through a test carried out in the Fajar University laboratory as for the results

Coarse Aggregate Physical Properties

The results of testing the physical properties of coarse aggregate carried out according to the Indonesian National Standard (SNI) testing method

Table 4. Characteristics of the physical properties of coarse aggregate

No.	Test	Interval value	Results	Information
1	Absorption %	Max 3	2,8	Fulfil
2	Specific gravity			
	a. Bulk specific gravity	Max 3	2,4	Fulfil
	b. SSD density	Max 3	2,56	Fulfil
	c. apparent density	Max 3	2,91	Fulfil
3	Wear (%)	Max 40	31	Fulfil
4	Flatness index (%)	Max 25	24,12	Fulfil

Source: Test results and calculations of Civil Engineering laboratory, UNIFA

Fine Aggregate Physical Properties

The results of testing the physical properties of fine aggregates carried out according to the Indonesian National Standard (SNI) testing method

Table 5. Characteristics of fine aggregate properties

No.	Test	Interval value	Results	Information
1	Absorption %	Max 3	2,04	Fulfil
2	Specific gravity			
	a. Bulk specific gravity	Max 3	2,72	Fulfil
	b. SSD density	Max 3	2,78	Fulfil
	c. apparent density	Max 3	2,88	Fulfil
3	Sludge levels (%)	Max 5	4	Fulfil

Source: Test results and calculations of Civil Engineering laboratory, UNIFA

Determination of Mixed Gradation In this study, the determination of the mixed gradation and mix design was carried out using a trial gradation system which refers to the open gradation standard required by REAM (Road Engineering Association Of Malaysia).

The percentage comparison used from each aggregate used in this study is coarse aggregate (85%): fine aggregate (5%): filler (10%) after that the aggregate sieve analysis that has been carried out is multiplied by the percent pass value. The results of these multiplications are added together to produce a mixed composition or mix design value. Determination of the proportion of aggregates is not grouped according to the aggregate fraction (coarse, fine and filler aggregates), but the determination of aggregate composition in this study is carried out by weighing based on the size of each sieve. Aggregate composition by gradation method by sieve

Table 6. Aggregate Merger

No. Sieve		3/4	1/2	3/8	No. 4	No. 8	No. 200
		19.00	12.50	9.50	4.75	2.36	0.075
Split	% Pass	100	84.00	48.50	0.00	0.00	0.00
85	% Batch	85	71.40	41.23	0.00	0.00	0.00
Sand	% Pass	100	100	100	100	81.50	13.50
5	% Batch	5	5	5	5	4.08	0.68
Filler	% Pass	100	100	100	100	57.50	14.00
10	% Batch	10	10	10	10	5.75	1.40
Mix agregate		100	86.40	56.23	15.00	9.83	2.08
Spesifikation		100	85 - 100	55 - 75	10 - 25	5 - 10	2 - 4

Source: Test results and calculations of Civil Engineering laboratory, UNIFA

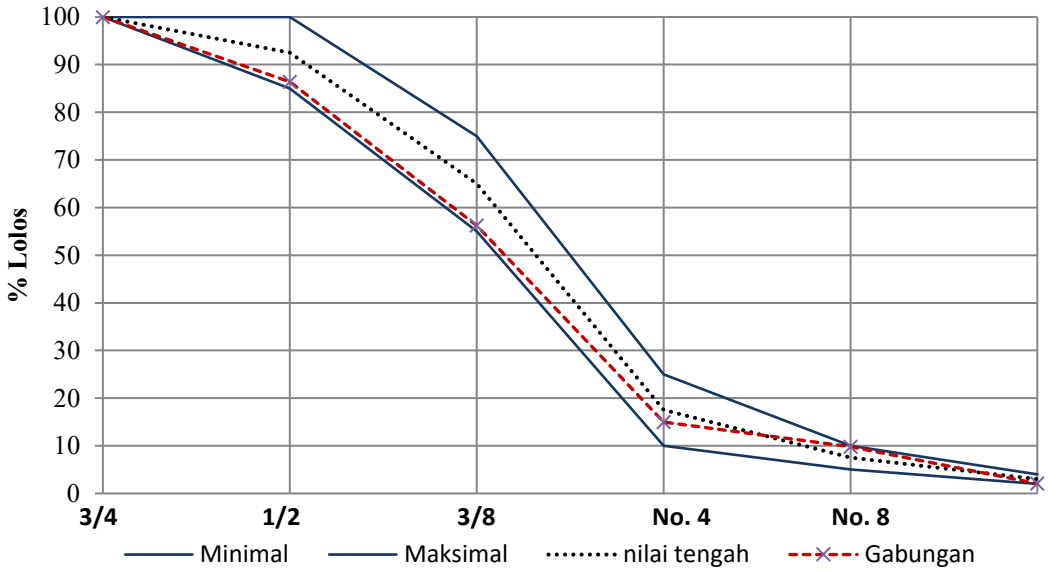

Figure 1. Graph Aggregate gradation

Cantabro Pengujian Test Results

From the test results, based on the specifications required by REAM, 2008 that the limit value of weight loss (cantabro) that can occur from the porous asphalt mixture is not more than 15%. The Cantabro test shows the durability of a test object. The smaller the weight loss that occurs in the test object, the more resistant the test object is.

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Table 7. Cantabro test results

Sample	Percentage Derby 401	Weight Before Test (Mo)	Weight After Testing (Mi)	Losing Weight	Average Weight Loss
				Mo-Mi	$\frac{(Mo-Mi)}{Mo}$ x 100
No	%	Kg	Kg	Kg	%
1	0.00	1228	1062	166	13,52
2	0.00	1222	1065	157	12,85
3	0.00	1225	1068	157	12,82
Average				160	13.06
1	0.1	1258	1165	93	7,39
2	0.1	1259	1165	94	7,47
3	0.1	1253	1168	85	6,78
Average				91	7.21
1	0.2	1237	1172	65	5,25
2	0.2	1225	1116	109	8,90
3	0.2	1241	1172	69	5,56
Average				81	6.57
1	0.3	1240	1170	70	5,65
2	0.3	1261	1178	83	6,58
3	0.3	1251	1174	77	6,16
Average				77	6.13
1	0.4	1225	1126	99	8.08
2	0.4	1237	1142	95	7.68
3	0.4	1223	1140	83	6.79
Average				**92**	**7.52**

Source: Test results and calculations of Civil Engineering laboratory, UNIFA

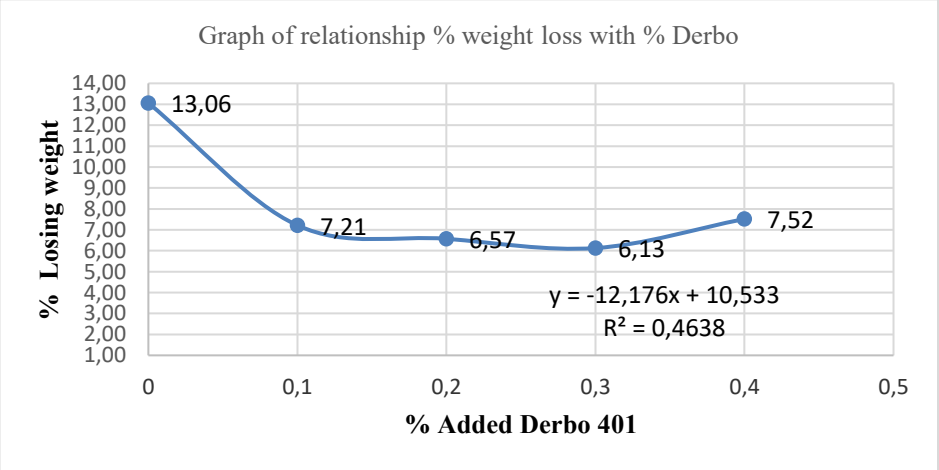

Figure 2. Graph of the relationship between % weight loss and % addition of Derbo 401

The graph above shows that the higher the percentage addition of Derbo 401, the lower the percentage of weight loss. At 0% Derbo Addition. The percentage value of weight loss is 13.06%, the graph decreases to 0.3% Derbo Addition. The percentage value of weight loss is 6.13% and the graph rises again at 0.4% Derbo addition percentage. The limit value for Weight Loss in REAM Specifications is a maximum of 15%. This shows that the performance of the porous asphalt mixture is getting better until the percentage addition of Derbo is 0.3%, as evidenced by the lowest Cantabro Loss value at the percentage addition of 0.3%.

Permeability Test Results

Permeability test is a comparison between the amount of water that can flow in every second. If the value of the lower permeability coefficient indicates the smaller the air voids in the mixture, so the mixture is not porous, and vice versa. The large and small value of the permeability coefficient is strongly influenced by the distribution and gradation of aggregate which will make the mixture denser. The permeability test on the test object was carried out using a constant head permeability (CHP) type of permeability test equipment. The following is an example of the calculation of the permeability test carried out: Volume of water accommodated (Q): 300 ml, Height of test object (L): 8.2 cm, Difference in height (h): 60 cm, Area of test object: 10 cm2, Time water flow: 16.38 seconds

Permeability Coefficient (cm³/sec)

$$K = \frac{Q}{t} x \frac{L}{h} x \frac{1}{A}$$

$$K = \frac{300}{12.27} \text{ x} \frac{8.2}{60} \text{ x} \frac{1}{10} = 0{,}334 \text{ cm}^3\text{/detik}$$

The complete permeability calculation can be seen in the Appendix. The results of the permeability test can be seen in the table 8.

Table 8. Permeability test

No	% Derbo 401	Water Volume Accommodated (Q)	Test Object Height (L)	Height Difference (h)	Test Object Area	Water Flow Time	Permeability Coefficient (cm3/sec)
1	0	300	8,2	60	10	12,27	0,334
	0	300	8,1	60	10	12,20	0,332
	0	300	8,2	60	10	12,25	0,335
							0,334
2	0.1	300	8,3	60	10	13,88	0,299
	0.1	300	8,2	60	10	13,87	0,296
	0.1	300	8,2	60	10	13,82	0,297
							0,297
3	0.2	300	8,2	60	10	14,30	0,287
	0.2	300	8,3	60	10	14,32	0,290
	0.2	300	8,1	60	10	14,35	0,282
							0,286
4	0.3	300	8,1	60	10	15,32	0,264
	0.3	300	8,2	60	10	15,64	0,262
	0.3	300	8,2	60	10	15,02	0,273
							0,266
5	0.4	300	8,3	60	10	16,38	0,253
	0.4	300	8,3	60	10	16,30	0,255
	0.4	300	8,1	60	10	16,31	0,248
							0,252

Source: Test results and calculations of Civil Engineering laboratory, UNIFA

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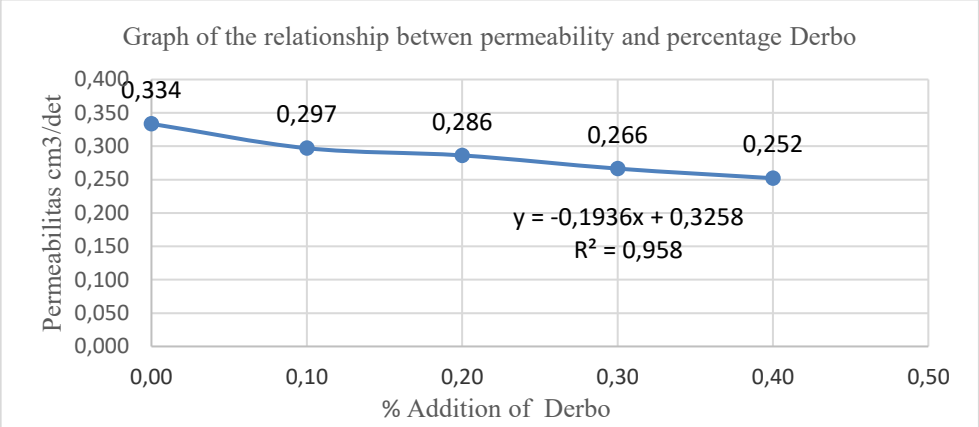

Figure 3. Graph of the relationship between the value of the permeability coefficient with the percentage addition of Derbo 401

From the graph above shows that the higher the percentage addition of the derby. Then the permeability value decreases. At 0% Derbo Addition percentage. with a permeability value of 0.334 cm3/sec. The graph drops to 0.4% Derbo Addition Percentage with a permeability value of 0.254 cm3/sec. The lower the permeability value indicates the smaller the air voids in the porous asphalt mixture.

X-Ray Fluoroscence (XRF) Test Results

The test results of the porous asphalt mixture with the addition of 0.3% Derbo in the Hasanuddin University Microstructure Laboratory can be seen in the following table:

Table 9. X-Ray Fluorosscence (XRF) test results

No	Element name	Element	%	Compound	%	Quality standards %	Status
1	Silikon	Si	13.93	Si02	29.79	-	Safe
2	calsium	Ca	21.12	CaO	29.53	-	Safe
3	sulfur	S	8.45	SO3	21.11	-	Safe
4	Ferrum	Fe	8.80	Fe2O3	12.58	-	Safe
5	kalium	K	2.42	K2O	2.91	-	Safe
6	Posforus	P	0.72	P2O5	1.65	-	Safe
7	Titanium	Ti	0.53	TiO2	0.89	-	Safe
8	Stronsium	Sr	0.361	SrO	0.426	-	Safe
9	Barium	Ba	0.367	BaO	0.410	-	Safe
10	Zirkonium	Zr	0.143	ZrO2	0.193	-	Safe
11	Niobium	Nb	0.111	Nb2o5	0.159	-	Safe
12	Molibdenum	Mo	0.0720	MoO3	0.108	-	Safe
13	Rubidium	Rb	0.055	Rb2o	0.060	-	Safe
14	Ruthenium	Ru	0.0344	RuO4	0.0453	-	Safe
15	Antimon	Sb	0.0305	Sb2O3	0.0365	-	Safe
16	Lantanum	In	0.0291	In2O3	0.0352	-	Safe
17	Stannum	Sn	0.0239	SnO2	0.0304	-	Safe
18	Rhodium	Rh	0.217	Rh2o3	0.0268	-	Safe

Source: Test results in the lab. Unhas. Microstructure

The table above shows that the elements that make up the porous asphalt mixture with the addition of Derbo percentage are more in the elements Si (silicon) 19.93%, Ca (calcium) 21.12%, S (sulfur) 8.45%, Fe (ferrum) 8.80%, K (potassium) 2.42% and less of the other elements. After being oxidized by O2 to form SiO2 29.79%, CaO 29.53%, SO3 21.11%, Fe2O3 12.58%, K2O 2.91% and other compounds less than 1%, the elements present in Derbo are not included in the chemical

parameters in the environmental health quality standards. for aqueous media. So the addition of the derby is still categorized as safe to use

CONCLUSION

Permeability coefficient of porous asphalt mixture 0.254 cm3/sec. the lowest percentage Derbo 0.4% The percentage addition of Derbo affects the value of the coefficient of permeability where the higher the percentage addition of Derbo the smaller the value of the coefficient of permeability obtained. has met the required specifications of a maximum of 0.3 cm3/sec.

The performance of the porous asphalt mixture with the percentage addition of Derbo to the weight loss value with the Cantabro test on the test object shows that the performance of the porous asphalt mixture is getting better up to the percentage addition of Derbo 0.3%, as evidenced by the lowest Cantabro Loss value at the percentage addition of 0.3% obtaining an average value 6.13% have met the required specifications max 15%.

The elements that make up the porous asphalt mixture with the addition of Derbo percentage are mostly Si (silicon) 19.93%, Ca (calcium) 21.12%, S (sulfur) 8.45%, Fe (ferrum) 8.80%, K (potassium) 2.42% and the other elements are less. After being oxidized by O2 it forms a compound SiO2 29.79%, CaO 29.53%, SO3 21.11%, Fe2O3 12.58%, K2O 2.91% and other compounds less than 1.0%, elements present in derbo, not in chemical parameters in quality standards environmental health for water media. So the addition of the derby is still categorized as safe to use.

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