DURABILITY OF ASPHALT CONCRETE MIXTURE USING LOMPOTO'O TRAS AS FINE AGGREGATE

Frice L. Desei[1], Ayuddin[2]

[1,2]Department of Civil Engineering, State University of Gorontalo, Jl. Jend. Sudirman No. 6, Gorontalo, Indonesia
fricedesei@yahoo.com[1]

ABSTRACT

This study attempted to use tras as a partial substitution material on fine aggregates in order to (1) find out the influence of the durability of AC-WC mixtures by using Lompoto'o tras and Wetfix-BE additives; (2) to know the ratio of the durability of the AC-WC mixture using the Lompoto'o tras and without using the Lompoto'o tras with the Wetfix-BE additive. The method used in this research is Marshall test data analysis technique according to Bina Marga 2010 specification (revision 3). Optimum asphalt content (KAO) of 6%, tras variation 0%, 10%, 20%, 30%, 40%, 50% and duration of immersion were 0,1,2,4,6 and 8 days.
The results showed. the longer the duration of the immersion value of the Time Strength Index decreases. The highest durability was achieved on the test specimen of 20% tras variation, 2 days duration of immersion, with an IKS value of 96.75%, and stability value of 1812.71 kg. The resulting IKS value still meets the specification standard that exceeds the minimum threshold of 90%, but the duration of the 8 day immersion has decreased in the mix of 0% tras variation. The First Durability Index (IDP) and the Second Durability Index (IDK) generally experience a power loss, except for the 20% and 30% tras variations instead of strength. The highest power loss occurred in the mix of 0% trace variation on the 1 day duration of the bath, while the highest strength increase occurred in the 20% mixture of tras variation on 2 day duration, with IDK value -0.04% and IDP value -0.75%. This indicates that the mixture using tras has better durability compared to the mixture without the use of tras
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Keywords**: 1. Durability;2. AC-WC ; 3. Tras

A. INTRODUCTION

One of the performance parameters of asphalt mixture is durability (endurance). Where durability is required on the surface layer so that the layer is able to withstand wear due to weather, water and temperature changes or wear and tear due to vehicle friction. Efforts to improve the quality of asphalt is commonly done by modifying it with the addition of additives or additives, one of which is the additive materials Wetfix-BE. The concrete asphalt mixture consists of various aggregate sizes, including fine Aggregates.
The commonly used soft aggregate is the result of stone crushing, but in this study try to use another alternative that is using natural material TrasLompoto'o as partial substitution. This material is located in Lompoto'o Village, Suwawa District, Bone Bolango District, Gorontalo Province, which is estimated to reach 4,000,000 m3 with an area of ± 16 ha (Achmad and Munjuk, 2014) .Tracer is a natural pozzolan material produced from weathering of volcanic eruption material, but in general from some writings that Trasmengandung silica (SiO2), alumina and iron alkali compounds, lime, and others, although in a weak level. From some description of the above problems, then the question arises a question that needs to be answered include:

1. What is the durability of an AC-WC mixture using TrasLompoto'o and the Wetfix-BE additive?
2. What is the ratio of AC-WC durability using TrasLompoto'o and without using Lompoto'otras with Wetfix-BE additive?

Research Objectives to be achieved from this research are:

1. Knowing the durability of AC-WC mixtures by using TrasLompoto'o and Wetfix-BE additives.
2. Knowing the comparison of the durability of the AC-WC mixture by using the Lompoto'oTras and without using the Lompoto'otras with the Wetfix-BE additive.

B. LITERATURE REVIEW

1. General

Tras are volcanic rocks that have undergone changes in chemical composition caused by

weathering and the effect of underground water conditions. This mineral material is yellowish white to brownish white, compact and unified. Tras are generally formed from volcanic rocks that contain much feldspar and silica, such as andesite breccia, granite, rhyolite, which have undergone further weathering. As a result of the feldspar weathering process will turn into clay / kaolin minerals and amorphous silica compounds. The higher the weathering rate the better the quality of the tras. As the building materials of tras have characteristic properties, the tras character is most important when mixed with lime outage (lime tohor) and water will have properties like cement. This property is caused by the amorphous silica (SiO2) oxide and aluminum oxide (Al2O3) in the tras which make it acidic. Tras in this research is as one of the alternative substances of aggregate partial substitution.

Figure 1. Location of Lompoto'oTras

2. Bit concrete (Asphalt Concrete)

Bit concrete is a type of pavement consisting of aggregate and asphalt mixtures, with or without additives. Asphalt concrete materials are mixed in the mixer installation at a certain temperature, then transported to a location, overlaid and compacted. The mixing temperature is determined by the type of bitumen to be used. When used asphalt cement, the mixing temperature is generally between 145o-155oC (Sukirman, 2003).

One of the asphalt mixed products now widely used by the Department of Settlement and Regional Infrastructure is AC-WC / Lapis Aus Asphalt Concrete. This layer is a layer that is directly related to vehicle tires and is designed to withstand weather changes, shear forces, vehicle tire wheel pressure and provide an impermeable layer for layers underneath.

3. Durabilias asphalt concrete mixture

Durability is a measure of pavement resistance to the decomposition due to traffic load. The durability level of a mixture is used the Time Strength Index (IKS) parameter, First Durability Index (IDP) and the Second Durability Index (IDK).

a) Standard durability testing method

A comparison of stability values immersed for 24 h with stability values soaked for 30 min, expressed in percent, and so called Time Strength Index (IKS) can be calculated by the following equation:

$$IKS = \frac{S_2}{S_1} \times 100\ \% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.2)$$

With,

IKS : Time Strength Index(%)

S1 : Standard Marshall Stability with soaking for30 menitus on temprature ± 60oC, (kg).

S2 : Marshall's stability after immersion 24 hours at ± 60oC, (kg).

b) Method of modification durability testing

According to Craus, J. et al (1981) states that the 1 day immersion criteria do not necessarily reflect the durability of the mixture after some period of immersion. In his research was introduced 2 kinds of durability index that is,

a. First Durabiltas Index (IDP)

The first index is defined as the number of consecutive slope of the durability curve. First durability index can also be defined as a decrease in the value of the sensitivity of the test object stability to prolonged submersion. First durability index expressed in (r) is calculated by the following equation,

$$r = \sum_{i=0}^{n-1} \frac{S_1 - S_{i+1}}{t_{i+1} - t_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.2)$$

With,

r: decrease the value of stability (%)

So: the absolute value of the initial strength

Si: percent of the time remaining on time t1

Si + 1: percent of the time remaining on time ti + 1

ti, ti + 1: soaking time (ranging from initial testing)

Rated 'R' positive when impaired stability that indicate loss of power, while the value of 'r'

negative when increased stability values that indicate the acquisition of power.

a. Both Durabiltas Index (IDK)

the percentage loss of average power for one day between the durability curve with the line S0 = 100 percent. The second durability index is expressed (a) calculated on the basis of the following equation,

$$a = \frac{1}{t_n}\sum_{i=1}^{n} a_i$$
$$= \frac{1}{2t_n}\sum_{i=0}^{n-1}(S_i - S_{i+1})[2t_n$$
$$-(t_i + t_{i+1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

With,

a: percentage loss of power for one day (%)

Si + 1: percentage of residual strength on time ti + 1 (%)

Si: percentage of residual strength on time ti (%)

ti, ti + 1: immersion period, begins from the start of the test (hours)

tn: total immersion time (hours)

This durability index represents a one day power loss. A positive 'a' value represents a loss of power, whereas a negative 'a' is an increase in strength. Based on that definition, it is a <100. Therefore, it is possible to declare the percentage of residual strength of a day (Sa) as follows,

$$S_a = 100 - a \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.4)$$

The value of the second durability index can also be expressed in terms of the absolute value of the equivalent loss of power as follows,

$$A = \frac{a}{100} \text{ x } S_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.5)$$

With,

A: The absolute value loses strength for one day (kg)

SO: The absolute value of initial strength (kg)

C. RESEARCH METHODS

This research was conducted at Civil Engineering Laboratory Faculty of Engineering, State University of Gorontalo, based on Marshall method which refers to General Specification of Bina Marga Year 2010 revision 3 and gradation of aggregate mixture used is AC-WC gradation. The materials used are in the form of broken stone, and stone ash production PT. SinarKaryaCahaya, and tras from Lompoto'o village, while asphalt material is using Pen asphalt 60/70 Pertamina production. The research diagram can be seen in Figure 2.

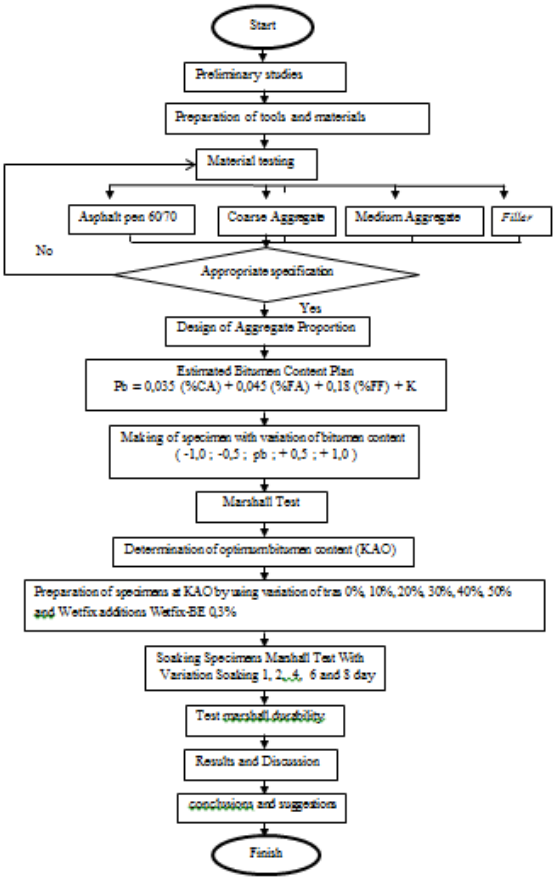


Figure 2. Flow Chart of Research

D. RESULTS AND DISCUSSION

1. Aggregate test results

From the results of the examination conducted at the Civil Engineering Laboratory Faculty of Engineering, State University of Gorontalo, obtained aggregate test results can be seen in Table 2.

All of the aggregate test results contained in Table 2. show that they have met the general specification, 2010 (revision 3).

Table 2. Results of the Aggregate Examination

Characteristics	Unit	Test result			Specification
		Coarse aggregate	Medium aggregate	Ash Stone	
Abrasion with Los Angeles Machine	%	26,07	26,53	-	Max. 40%
Specific gravity of Bulk	gr/cc	2,70	2,61	2,54	-
Specific gravity of SSD	gr/cc	2,72	2,64	2,57	-
Specific gravity of Apparent	gr/cc	2,75	2,70	2,61	-
Water Absorption	%	0,70	1,25	1,11	Max. 3%
Flat particles	%	9,92	9,73	-	Max. 10%
Particle Oval	%	9,90	9,91	-	Max. 10%
Butriran Size Distribution	%	99,09/95.45	99,09/95.45	-	95/90*)
Water content	%	0,19	0,69	2,56	
Coarse aggregate pass filter No. 200	%	0,02	0,02	-	Max. 2%
Sand pass filter No. 200	%	-	-	8.59	Max. 10%

4.2 TrasLompoto'o

This tras originated from Lompoto'o Village, Suwawa District. Previously tras has been carried out preliminary test at the Chemical Laboratory Faculty of Mathematics, State University of Gorontalo, this is done to determine the content of composition and chemical elements in the tras. Test results of chemical content on tras can be seen in Table 3.

From the results of chemical analysis in Table 3.shows that the compounds of dominant elements contained in TrasLompoto'o are Fe2O3 and SiO2 ..

Table 3. Test Result of Chemical Composition of TrasLompoto'o

No	Test Parameters	Composition	
		Sample 1	Sample 2
1	Fe_2O_3	46,51%	38,14%
2	SiO_2	25,79%	31,69%
3	SrO	10,07%	10,14%
4	CaO	8,66%	9,17%
5	K_2O	3,54%	4,02%
6	TiO_2	1,55%	3,69%
7	MnO	1,41%	1,07%
8	ZrO_2	0,82%	0,71%
9	Rb_2O	0,55%	0,52%
10	Y_2O_3	0,52%	0,50%
11	PbO	0,28%	0,15%
12	CuO	0,19%	0,13%
13	ZnO	0,11%	0,08%

2. Asphalt test results

Asphalt test was conducted to find out the asphalt characteristic to be used in concrete asphalt mixture. Asphalt used is a hard asphalt pertamina production with penetration 60/70, from the results of laboratory tests obtained data from the test results in Table 4.

Based on the test results it can be seen that the asphalt characteristic values have met the General Specification, 2010 (revision 3) and can be used as AC-WC mixture..

Table 4. Asphalt Test Results

No	Description	Test method	Specification	Results
1	Penetration at 25°C (dmm)	SNI 06-2456-1991	60-70	65,3
2	Specific gravity of Asphalt	SNI 2441:2011	≥1,0	1,04
3	Specific gravity of Asphalt + *Wetfix-BE*	-	-	1,07
4	The soft spot (°C)	SNI 2434:2011	≥48	59,5
5	Flash point (°C)	SNI 2433:2011	≥232	280
6	Fuel Point (°C)	-	-	320
7	Ductility on 25°C (cm)	SNI 2432:2011	≥100	136

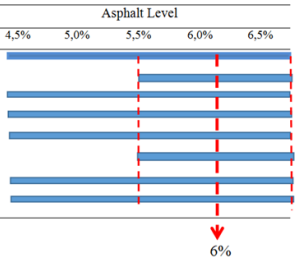
3. Optimum asphalt content

Determining KAO is done by entering all Marshall test results into bar chart based on Marshall characteristic parameters ie density, stability, flow, VMA, VIM, VFB, BFT, and MQ values in Table 5. The result of determination of optimum bitumen content obtained by 6% can be seen in figure 3.

Table 5. Characteristics of Marshall with variation of Aaspal

Content asphalt	Characteristics of Marshall							
	Density	VIM	Stability	VMA	*Flow*	MQ	VFA	TFA
4.5	2.29	6.86	2093.04	15.57	2.51	833.22	55.95	7.21
5.0	2.28	6.35	2363.77	16.15	2.41	980.01	60.68	8.17
5.5	2.30	4.96	2488.95	15.95	2.31	1076.53	68.88	9.14
6.0	2.29	4.85	1880.54	16.88	3.18	592.11	71.25	10.12
6.5	2.29	3.14	1836.87	17.28	3.33	551.94	76.06	11.10

Parameter	Unit	Specifications	Asphalt Level
			4,5% 5,0% 5,5% 6,0% 6,5%
Density		-	
VIM	%	3 - 5	
VMA		≥ 15	
Stability	kg	≥ 800	
Flow	%	2 - 4	
VFB	%	≥ 65%	
TFA		-	
MQ	Kg/nm	≥ 250	



4. Durability of asphalt concrete mixture (Asphalt Concrete)

The main factor affecting durability is the value of stability, and to see the level of performance of asphalt durability used some indicator that is Time Strength Index (IKS), Time Stability Decrease Index (IPS) include First Durability Index (IDP) and Second Durability Index (IDK).

Based on Figure 4.it can be seen that the value of stability decreases with the duration of immersion. The highest stability value was found in 30% tras variation with 1 day duration of 1902.18 kg, while the lowest stability was found on 0% variation of tras with 8 days duration of 1313.90 kg. An excessive mixture of tras will reduce the interlocking force causing less friction resistance. Here is a graph of the relationship of stability, variation of tras with the duration of immersion.

Table 6. Value of stability, KAO with variation of Tras and Duration of Immersion

The nature of Marshall	Variation	Duration of Immersion (Day)					
	Tras	0	1	2	4	6	8
Stability (Kg)	-	1701.18	1577.75	1563.44	1507.81	1453.51	1313.91
	10%	1787.84	1674.30	1654.91	1616.13	1525.46	1440.94
	20%	1873.56	1795.33	1812.71	1753.60	1619.87	1581.76
	30%	1902.18	1788.64	1801.21	1762.97	1651.84	1566.25
	40%	1813.11	1706.80	1684.20	1616.93	1524.39	1406.71
	50%	1704.93	1608.51	1586.71	1512.62	1464.08	1359.23

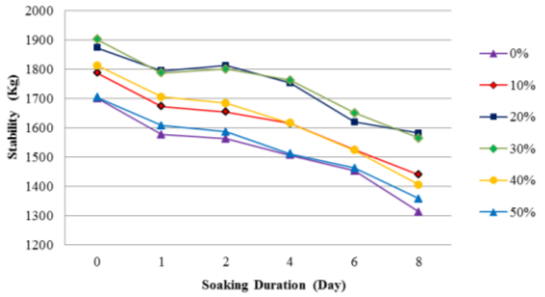


Figure 4. Graph of relation of stability value with variation of tras and duration of immersion

Relationship Flow with Variations Tras and Duration Immersion

Flow is an indicator of the flexibility of hot asphalt mixture in holding traffic load. In Figure 5.it shows that, the longer the duration of immersion then there is an increase in the value of flow tend to be plastic and easily formed. The lowest flow rate was found in the mixture using 30% tras variation in 1 day immersion of 2.71%. And the highest flow value is found in mixture with 0% of 0% variation on 8 day soak is 6,93%.

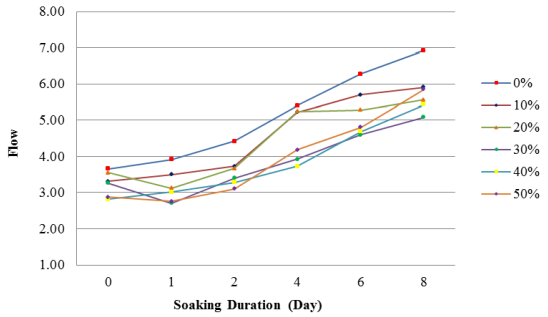


Figure 5. Graph of the relationship of flow value with variation of tras and duration of immersion

Relationship Results For Marshall (MQ) with Variations Tras and Duration Immersion

Marshall Value Quotient (MQ) is the quotient between stability and fatigue (flow) and an approach to the level of rigidity and flexibility mix. 6. The image can be seen on the MQ values decrease with the duration of the immersion, it is due to the tras make the mixture become more supple and flexible. MQ value was lowest for the mixture with 8 days immersion is 189.60 kg / nm, while the highest value contained in the mixture.

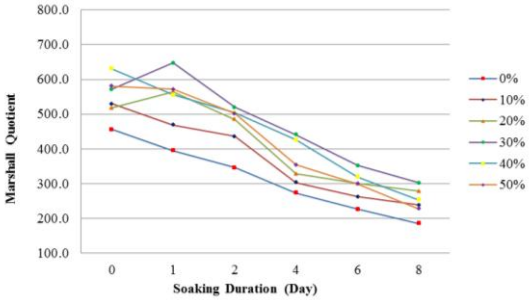


Figure 6. Graph relationship with variations tras MQ value and duration of immersion

Han association Remaining Strength Index (IKS) to the Tras and Duration Variations Immersion

The results of the test in Table 7. show that the value of IKS for the variation of 0%, 10%, 20%, 30%, 40% and 50% tras with Marshall 1 and 2 day Marshall modification gives result which still fulfill the requirement set by Bina Marga is at least 90%. In 4 day immersion value of IKS still exist that fulfill general specification, 2010 revision 3 that is on tras variation 10%, 20%, and 30%, but at 0%, 40%, and 50% tras variation have not fulfilled general spesification, 2010 (revision 3). While on Marshall's 6th and 8th day the IKS score is not meeting the predetermined standard of DGH. This shows that the value of IKS decreases with increasing duration (duration) of immersion.

The presence of additional tras provides a higher level of durability compared with those not using tras, as well as the decreased durability along with the duration of immersion. Based on Table 7.shows the increase of IKS in 2 day immersion with 20% tras variation by obtaining the highest IKS value of 96.75% and the lowest value is in the 8 day bath with 0% tras variation is 77.23%. From figure 7 it can be seen that 20% tras variation has the highest IKS value in 1, 2, 4 and 8 day immersion except for 6 day immersion. The lowest value of IKS is at 0% tras in 8 days' bath. So the highest IKS value is on 20% tras variation.

Table 7. Test Results of IKS with Variation of Tras and Duration of Immersion

The Nature of Marshall	Variation	Soaking Duration (Day)					
	Tras	0	1	2	4	6	8
Stability Time (%)	-	100.00	92.74	91.90	88.63	85.44	77.23
	10%	100.00	93.65	92.56	90.40	85.32	80.60
	20%	100.00	95.82	96.75	93.60	86.46	84.43
	30%	100.00	94.03	94.69	92.68	86.84	82.34
	40%	100.00	94.14	92.89	89.18	84.08	77.59
	50%	100.00	94.34	93.07	88.72	85.87	79.72

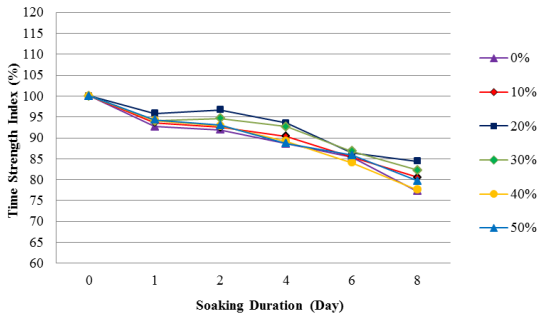


Figure 7. Graph of relationship between IKS with variation of tras and duration of immersion

Relation of First Durability Index (IDP) with Variation of Tras and Duration of Immersion.

Based on Table 8.it can be seen that the loss of power starts to occur on the 1st, 4th, 6th and 8th day soaks in the mixture without tras and on the tras variation. The largest loss of power occurred in the mixture without tras with 1 day immersion with r = + 0.30%. Meanwhile, in the second day soak on 20% and 30% of the tras variation there was an increase of strength with each obtained -0.04% and -0.03%. For the greatest strength addition is found in the mixture using 20% tras variation with r value of -0.04%.

Table. 8. Result of IDP test with variation of tras and duration of immersion

The Nature of Marshall	Variation	Soaking Duration (Day)					
	Tras	0	1	2	4	6	8
r (%)	-	0.00	0.30	0.04	0.07	0.07	0.17
	10%	0.00	0.27	0.05	0.05	0.11	0.11
	20%	0.00	0.17	-0.04	0.07	0.15	0.04
	30%	0.00	0.25	-0.03	0.04	0.12	0.12
	40%	0.00	0.24	0.05	0.08	0.11	0.14
	50%	0.00	0.24	0.07	0.08	0.06	0.13

Relationship of Second Durability Index (IDK) with Variation of Tras and Duration of Immersion

In the test results Table 9. shows most of the mixtures of both without using a mixture of tras and variations of tras accompanied by the length of immersion produce a positive value which means experiencing power loss. Loss of strength begins in the 1st, 4th, 6th and 8th baths in the mixture without tras and on the tras variation. The greatest loss of power was found without trash mixture at 1 day soak at + 6.80%, while the addition of strength in the second day bath on the 20% and 30% tras variation with each value obtained -0.75% and -0.54%. The greatest strength increase occurred in 2 day soak with 20% tras variation of a -0.75% value.

The highest residual equivalent of residual weight (Sa) was found in the mixture using tras with 20% tras variation with a duration of 2 days immersion of 100.75%, while the lowest (Sa) value was found in the mixture without using tras with 1 day immersion duration of 93, 20%. IDK testing results can be seen in Table 9. below.

Table. 9. IDK test results with variations of Tras and Duration of Premens

The Nature of Marshall	Variation	Soaking Duration (Day)					
	Tras	0	1	2	4	6	8
a (%)	-	0.00	6.80	0.68	2.04	1.20	1.03
	10%	0.00	5.95	0.88	1.36	1.90	0.59
	20%	0.00	3.91	-0.75	1.97	2.68	0.25
	30%	0.00	5.60	-0.54	1.26	2.19	0.56
	40%	0.00	5.50	1.01	2.32	1.91	0.81
	50%	0.00	5.30	1.04	2.72	1.07	0.77
Sa (%)	-	100.00	93.20	99.32	97.96	98.80	98.97
	10%	100.00	94.05	99.12	98.64	98.10	99.41
	20%	100.00	96.09	100.75	98.03	97.32	99.75
	30%	100.00	94.40	100.54	98.74	97.81	99.44
	40%	100.00	94.50	98.99	97.68	98.09	99.19
	50%	100.00	94.70	98.96	97.28	98.93	99.23

E. CONCLUSIONS

Based on the research and discussion that has been described can be concluded that:

1. Influence caused by the addition of tras mixture with variation of 0%, 10%, 20%, 30%, 40% and 50% tras, and 0.2% Wetfix-BE additive material on the immersion duration of 0, 1, 2 and 4 day to the remaining Strength Index (IKS) is still greater than 90%, but in the period of 6 and 8 days there is a decrease in durability below that of the specification of the clan so it does not meet the standards. This shows that the value of IKS decreased with increasing duration of immersion.
2. Comparison of durability value using variation of tras and without using variation of tras with additive material Wetfix-BE 0,3% at immersion duration 0,1,2,4,6 and 8 day give result that, highest value of IKS exist in mixture with using a 20% tras variation of 96.75% in 2 day bath, while the lowest IKS value on the mixture without using tras amounted to 77.23% for 8 days duration with 0% tras variation. The highest strength increase in IDP occurred in the mixture using 20% tras variation with a 2-day immersion duration of -0.04%, while the greatest power loss occurred in a 0% tras mixture with a duration of 1 day + 0.30%. In IDK, the highest strength increase occurred in the mixture of 20% tras variation with a 2-day

immersion duration of - 0.75%, while the greatest power loss occurred in a 0% tras mixture with a duration of 1 day + 6.80%. This indicates that mixtures using tras variation are better than mixtures without using tras variation. Ideal variation is owned by a mixture of 20% tras with an IKS value of 96.75%.

Suggestions

Some suggestions that need to be considered in connection with this research are:

1. Based on the parameters of Marshall testing of AC-WC mixture that has been done before in this research, it is necessary to utilize TrasLompoto'o in AC-WC mixture to be tested by the government on road works implementation.
2. Tras utilization should be tested for durability in concrete asphalt layer such as in AC, Base, and for Lataston such as HRS-WC and HRS-Base.
3. The results of this study are expected to provide an overview and benefit for all parties related especially the government of Gorontalo Province and companies engaged in road construction, that the material TrasLompoto'o can be used as a mixture of plywood layer.

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