05. Utilizing Seashells Waste as Filler on Concrete Asphalt Mixture

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Utilizing Seashells Waste as Filler on Concrete Asphalt Mixture

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Abstract-Lots of seashells waste accumulates on the beach, its existence is very disturbing to the environment and causes foul odours. So far, the utilization of seashells waste has not been optimal, for this reason, in this study seashells waste were used as fillers in concrete asphalt mixtures. Variations of seashells waste used are 0%, 5%, 10%, 15%, 20% and 25% of fine aggregate weight. To determine the resistance to temperature and water, immersion was carried out with variations of 0.5 hours, 6 hours, 24 hours and 48 hours. This study uses the One-Way ANOVA statistical analysis. From the results of the study, seashells waste in asphalt concrete mixture has a positive effect on the value of Marshall stability and flow. Addition of 10% seashells waste from fine aggregate weight will increase the value of Marshall stability and flow. With the addition of 10% seashells waste, Marshall stability was increased by 36.752%, and for flow by 1.89% from normal concrete asphalt mixture. The relationship of the variation of seashells waste to Marshall stability has a negative effect because the value of Marshall stability decreases compared to without immersion. In the flow test with immersion, the addition of 10% seashells waste in the concrete mixture can increase the binding capacity between the asphalt and aggregate. This increase in binding capacity causes the concrete asphalt mixture to withstand immersion for up to 24 hours. At 24-hour immersion, the flow value is 3.47 mm.

Keywords*-Seashells Waste, Concrete Asphalt Mixture, Marshall Stability, Flow, Immersion*

I. Introduction

Indonesia is a maritime country. The fisheries sector under the leadership of Minister Susi Pudjiastuti experienced a rapid increase [1]. The fishing industry has also increased. On the other hand, the waste generated from the fishing industry is also increasing. One of the industrial wastes is seashells waste. The seashells waste is not optimally utilized, in the fishing village, this waste accumulates so that it disturbs the environment. The beach as a tourist destination is also disrupted by this seashells waste so that tourist visitors are decreasing. So far, seashells waste has been used to mix cosmetics, ceramics, cement, concrete mixture and seashells ornaments [2][3]. The seashells waste contains SiO_2 compounds. SiO_2 has good chemical stability, is not soluble in water and has a high-temperature resistance. The nature of SiO_2 is very appropriate if used as a filler in the concrete asphalt mixture. Filler in concrete asphalt mixture is a fine-grained material that functions as a cavity filler in the mixture. The filler granules must pass the sieve no. 200 [4][5]. The types and properties of fillers are:

1) The added fillers consist of fly ash and limestone dust
2) The added filler must be dry and not lumpy.

Addition of filler to the concrete asphalt mixture causes the layer to become harder because the pore content decreases [6]. The filler particles fill the cavity between the larger particles. Giving fillers is intended to increase the stability and density of the concrete asphalt mixture. The function of the filler is [7]:

1) Improve fine aggregate gradation, so that the density of fine aggregates increases.
2) Reducing the use of asphalt
3) Reducing the air void.
4) Filling the cavity between fine and coarse aggregates so that it can increase density and stability.
5) Add contact fields between aggregate grains so as to increase stability.
6) When mixed with asphalt, the filler will form a high-consistency binder so that it binds the aggregate granules together.

The main strength of the asphalt concrete mixture is the interlocking strength between fine aggregates, coarse aggregates and fillers. The amount of filler in the concrete asphalt mixture is limited. Too much filler, the concrete asphalt mixture becomes very stiff and easily cracked, besides it requires more asphalt [8]. In contrast, lack of filler, concrete asphalt mixture becomes very flexible and easily damaged by the wheels of the vehicle so that the road becomes bumpy.

Figure 1: Seashells Waste

Figure 1 shows the seashells waste before they are pounded. In order to become a filler, the seashells waste is crushed first and pass the sieve no. 200. The results of testing the composition of the chemical compounds of seashells waste can be seen in table 1.

TABLE I. A COMPOSITION OF SEASHELLS WASTE CHEMICAL COMPOUNDS

Chemical Compounds	Seashells Waste (%)
SiO_2	69.63
Al_2O_3	2.24
Fe_2O_3	3.70
CaO	61.2
MgO	0
SO_3	0.16
LOI	33.12

Source: Laboratory Results

Road damage is generally caused by vehicle loads, poor drainage, temperature and low quality of asphalt used [9][10]. For this reason, the Marshall stability, flow and immersion tests were conducted. The aim of the Marshall stability test is to determine the ability of concrete asphalt mixture to resist deformation caused by traffic loads. Stability depends on internal friction and cohesion [11]. While the friction depends on surface texture, aggregate gradation, the form of a combination of internal friction and the interlocking ability of the aggregate in the mixture [12]. Variables that affect stability include :

1) Friction.
   Friction depends on the aggregate shape, surface roughness and gradation.
2) Cohesion.
   Cohesion is the adhesion of each particle of pavement material. Rock cohesion will be seen from its hardness and mixed cohesion depending on aggregate gradation, bitumen adhesion and additive properties.
3) Inertia.
   Inertia is the ability of the pavement layer to resist the displacement that occurs due to traffic loads and loading time.

The stability that is too high causes the pavement layer to become stiffer and quickly crack, besides that because the void volume is less, resulting in the required bitumen content is low. This causes thin asphalt layers and asphalt bonds to escape so that durability is low. Stability occurs from the result of shifting between grains, locking between particles and good bonding capacity of the asphalt layer. High stability is obtained using:

1) Asphalt with sufficient amount for bonding between grains.
2) Asphalt with low penetration.
3) Aggregates with rough and cube-shaped surfaces.
4) Aggregates with tight gradations.

Aggregates with tight gradations make the cavity between small aggregates granules. Small Void in Mineral Aggregate (VMA) results in the asphalt being able to only cover aggregates in a limited manner and produce a thin bitumen asphalt. The thin asphalt layer is easily separated and results in the coating not being waterproof, oxidation often occurs, and the pavement layer becomes easily damaged. Too much use of asphalt results in the asphalt being unable to cover the aggregate properly (because of the small VMA) and also producing small voids in the mix. With traffic loads, compaction increases so that the asphalt layer easily melts.

In this study, there were two Marshall stability tests carried out, namely the Marshall stability test without immersion and with immersion. The Marshall Immersion Test aims to measure the adhesion resistance of concrete asphalt mixture to the influence of water and temperature [13][14].

The relationship between stability and flow is directly proportional, the greater the stability, the greater the flow, and vice versa [15][16]. So the greater the stability, the concrete asphalt mixture will be more able to withstand the load and vice versa. And if the flow gets higher then the asphalt is able to withstand the load. Flow is a vertical deformation that occurs from the beginning of loading until the condition of stability decreases. The amount of deformation that occurs in the pavement layer due to holding the load received. Flow values are influenced by asphalt viscosity, bitumen content, aggregate gradation and temperature. In this study, seashells waste were used as fillers in concrete asphalt mixtures, with the hope of increasing the quality of concrete asphalt. In addition, to increase the use value of seashells waste. The location for sampling seashells waste in Kalanganyar Village, Sedati District, Sidoarjo.

II. METHODOLOGY

The stages in the study of seashells waste on concrete asphalt mixture are as follows:

1. Preliminary test to determine optimum asphalt content, variations used are 4%, 4.5%, 5%, 5.5%, and 6%.
2. The seashells waste as a filler must be pounded first and pass the sieve filter no. 200. The variation of seashells waste used is 0%, 5%, 10%, 15%, 20% and 25% of fine

aggregate weight. Each filler variation consisted of 3 samples.

TABLE 2. TEST MODEL

Seashells Waste Variations					
0%	5%	10%	15%	20%	25%
3X	3X	3X	3X	3X	3X
3X	3X	3X	3X	3X	3X
3X	3X	3X	3X	3X	3X

3. To determine the durability and resistance to temperature and water, Marshall immersion tests were carried out for 30 minutes, 6 hours, 24 hours and 48 hours with a temperature of 60 ° C. Each variation of immersion consists of 3 samples.

TABLE 3. IMMERSION TEST MODEL

Immersion			
0.5 hours	6 hours	24 hours	48 hours
3X	3X	3X	3X
3X	3X	3X	3X
3X	3X	3X	3X

4. The effect of variations in seashells waste on Marshall stability and flow can be determined by one-way ANOVA statistical test. The hypothesis is as follows:

H_0: $\alpha_1 = \alpha_2 = \alpha_3 = ... = \alpha_n$, there are no significant differences/influences.

H_1: $\alpha_n > 0$, there are significant differences/influences.

With the help of SPSS software, an analysis was carried out so that F_{Value} was obtained and compared to F_{Table} with degrees of freedom α = 5%. If the value of $F_{Value} > F_{Table}$ means H_0 is rejected and if the $F_{Value} < F_{Table}$ means H_0 is accepted.

5. The next step, a one-way regression is carried out to determine the relationship of variations in the seashells waste with Marshall stability and flow.
6. From one-way regression, the optimum seashells waste is also obtained.
7. The next test is the immersion test using optimum seashells waste with a variation of 30 minutes, 6 hours, 24 hours and 48 hours.

III. DISCUSSION

From the results of the preliminary test to determine the optimum asphalt content results are obtained as in table 4.

TABLE 4. MARSHALL TEST RESULTS FOR OPTIMUM ASPHALT

No	Characteristics	Terms	Percentage of asphalt to total aggregate				
			4	4.5	5	5.5	6
1	VMA (%)	min. 15	65.95	65.64	66.42	65.47	64.88
2	VFA (%)	min. 60	60.71	61.85	60.02	62.98	64.94
3	VIM (%)	3,5 – 5,5	25.94	25.06	26.56	24.28	22.77
4	Stability (Kg)	min. 800	1006.96	1026.40	1342.83	1379.19	1262.01
5	Flow (mm)	min. 3,0	3.36	3.58	3.21	3.27	3.47
6	MQ (Kg/mm)	min. 250	370.15	286.93	339.37	342.23	295.10

Source: Research results

From table 4, the optimum percentage of asphalt chosen is 4%, because the value of VMA, VFA, Marshall Stability, Flow and Marshall Quetions (MQ) meet the characteristics of asphalt [17]. Besides that, the Marshall Quetions value is the biggest compared to the others. After determining the optimum percentage of asphalt which is equal to 4%, the experiment is continued by making a test object, with a variety of seashells waste added. Each variation consists of 3 samples so that the total sample is 30 samples.

A. Test of Seashells waste Variation Against Marshall Stability

By using the optimum percentage of asphalt 4%, the next experiment was carried out by adding seashells waste with variations of 0%, 5%, 10%, 15%, 20% and 25% of fine aggregate weight. The results of the test of a seashells waste variation on Marshall stability as in table 5.

TABLE 5. MARSHALL STABILITY TEST RESULTS

Seashells Waste Variations					
0%	5%	10%	15%	20%	25%
1008.05	1266.61	1289.52	1315.7	1403.31	916.41
998.23	1250.24	1260.06	1325.52	1358.25	923.68
1014.59	1292.79	1315.7	1341.88	1374.61	945.86

Source: Research results

Furthermore, statistical tests were carried out to determine the effect of seashells waste variations on Marshall stability. By using one-way ANOVA, the results are as shown in table 6.

TABLE 6. ANOVA TEST RESULTS

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	687393.37	5	137478.67	553.89	4.77E-19	2.77
Within Groups	4467.71	18	248.21			
Total	691861.08	23				

From table 6, it can be concluded that $F_{Value} > F_{Table}$ = 553.89> 2.77. This means that H_0 is rejected and H_1 is accepted, meaning that the variation of seashells wastes influences Marshall stability. Whereas to find out the relationship between the variation of the seashells waste to Marshall stability, one-way regression was performed. From the regression results, the equation is as follows:

$$Y = 997.43 + 61.19X - 2.45X^2 \quad (1)$$

With : Y = Marshall Stability (kg)
X = Seashells Waste Variation (%)
$R^2 = 0.81$
$R = 0.79$

With equation (1) it can be graphed the relationship of variations in the seashells waste with Marshall Stability, as in figure 2.

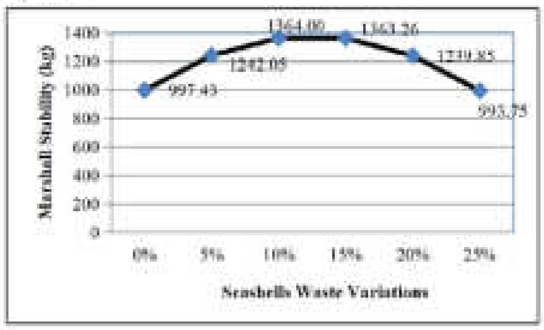

Figure 2. Graph of Relationship between Seashells Waste Variation Against Marshall Stability

From figure 2, the value of Marshall stability has increased with an increasing percentage of the seashells. The biggest increase occurred in 10% seashells waste percentage with Marshall stability value of 1364 kg. When compared with 0% seashells waste, there was an increase in Marshall stability of 36.752%. The 10% seashells waste percentage is the optimum seashells waste percentage. At 15% to 25% seashells waste percentage there was a decrease in the value of Marshall stability. Even for 25% seashells waste, Marshall stability is lower than 0% seashells waste.

B. Seashells Waste Immersion Test Against Marshall Stability

The next test is to determine the durability of concrete asphalt mixtures with 10% seashells waste with immersion on the Marshall stability. In this experiment, each variation of immersion consisted of 3 samples. Each specimen was soaked before the Marshall stability test. Marshall stability test results, mixed asphalt concrete with 10% seashells waste with immersion, as shown in table 7.

TABLE 7. MARSHALL STABILITY TEST RESULTS WITH IMMERSION

Immersion			
0.5 hours	*6 hours*	*24 hours*	*48 hours*
1102.96	1063.69	1040.78	1008.05
1129.15	1030.96	1047.32	1014.59
1106.24	1080.05	1034.23	1001.5

Source: Research results

To find out the effect of 10% seashells waste with immersion on Marshall stability a one-way ANOVA test was performed, as shown in table 8 below.

TABLE 8. ANOVA TEST RESULTS

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	23025.12	3	7675.04	50.38	4.5E-07	3.49
Within Groups	1828.11	12	152.34			
Total	24853.23	15				

From table 8 above, we get $F_{Value} > F_{Table} = 50.38 > 3.49$. This means that H_0 is rejected and H_1 is accepted. 10% seashells waste with immersion affect the value of Marshall stability. To find out the relationship between the two carried out regression analysis. Equation (2) is the result of a one-way regression analysis.

$$Y = 1100.52 - 3.8X + 0.04X^2 \quad (2)$$

Where : Y = Marshall Stability (kg)
X = Immersion (hours)
$R^2 = 0.79$
$R = 0.74$

From equation (3) a graph of the relationship between the two can be made, as shown in figure 3.

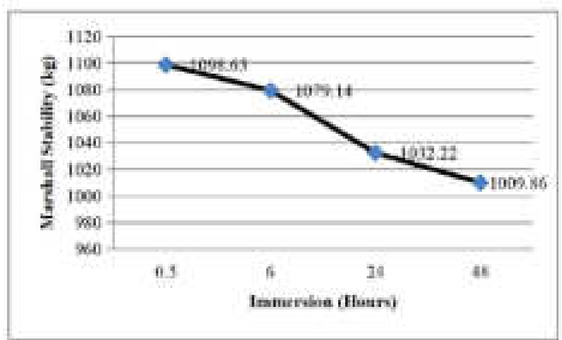

Figure 3. Graph of the Relationship of 10% Seashells Waste with Immersion Against Marshall Stability

Figure 3 above shows that the asphalt mixture of concrete with a variety of seashells waste is not resistant to immersion. This can be seen from the lower Marshall stability. The longer the soaked, the smaller the Marshall stability value.

C. Test The Variation of Seashells Waste Against The Flow

With the same steps as the Marshall stability test, a variation of seashells waste is tested against the flow. From the results of the flow test the results are as shown in table 9:

TABLE 9. FLOW TEST RESULTS

Seashells Waste Variations					
0%	*5%*	*10%*	*15%*	*20%*	*25%*
3.36	3.5	3.55	3.4	3.2	3.15
3.47	3.77	3.53	3.31	3.1	3.1
3.26	3.6	3.54	3.44	3.33	3.27

Source: Research results

Then one-way ANOVA statistical tests were carried out to determine the effect of seashells waste against the flow.

TABLE 10. RESULTS OF ANOVA SEASHELLS WASTE TEST AGAINST FLOW

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.63	5	0.13	8.67	0.001	3.11
Within Groups	0.17	12	0.01			
Total	0.80	17				

From table 10, it can be concluded that the seashells waste affect flow. This is due to $F_{Value} > F_{Table}$ = 8.67 > 3.11, which means H_0 is rejected and H_1 is accepted. The relationship between waste seashells and flow is expressed by the equation:

$$Y = 3.44 + 0.02X - 0.001X^2 \quad (3)$$

Where: Y = Flow (mm)
X = Seashells Waste Variations (%)
$R^2 = 0.62$
R = 0.56

With equation (3) above, the next process draws a graph of the relationship between seashells waste variations against the flow, like Figure 4.

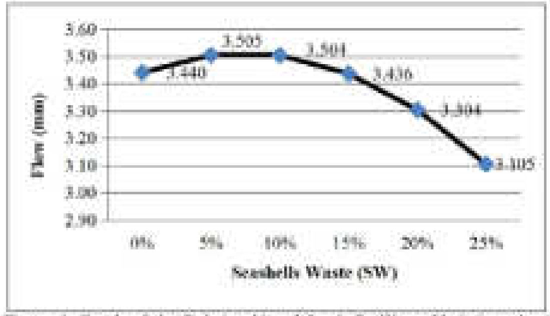

Figure 4. Graph of the Relationship of Seashells Waste Variations Against Flow

From figure 4, the addition of seashells wastes 5% to 10% can increase the value of flow. The highest flow value is 3.505 mm. The addition of seashells waste by 5% can increase the flow value by 1.89%. While the addition of 15% to 25%, the flow value decreases.

D. Test of Immersion Seashells Waste Variation Against Flow

The immersion test was carried out to determine the resistance of the variation of seashells waste to temperature and water. In this immersion test, the variation of seashells waste used is 5%. From the results of the immersion test on flow the results are as follows:

TABLE 11. IMMERSION TEST RESULTS AGAINST THE FLOW

Immersion (hours)			
0.5	*6*	*24*	*48*
3.2	3.47	3.44	3.4
3.24	3.32	3.44	3.4
3.33	3.46	3.47	3.48

Source: Research results

Statistical analysis was performed to determine the results of the immersion test against the flow. From the analysis of one-way ANOVA, the relationship is as follows:

TABLE 12. ANOVA RESULTS OF IMMERSION SEASHELLS WASTE AGAINST THE FLOW

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.07	3	0.02	6.74	0.01	4.07
Within Groups	0.03	8	0.003			
Total	0.10	11				

From the ANOVA test results, the value of $F_{Value} > F_{Table}$ = 6.74 > 4.07. This result shows that H_0 is rejected and H_1 is accepted. Seashells waste with immersion affects the flow value. To determine the relationship of flow value against immersion seashells waste, regression analysis was performed.

The results of one-way regression analysis are obtained equation (4).

$$Y = 3.29 + 0.01X - 0.0002X^2 \quad (4)$$

With: Y = Flow (mm)

X = Immersion Variations (hours)

$R^2 = 0.55$

$R = 0.44$

The graph of the relationship between Flow against immersion can be seen in Figure 5.

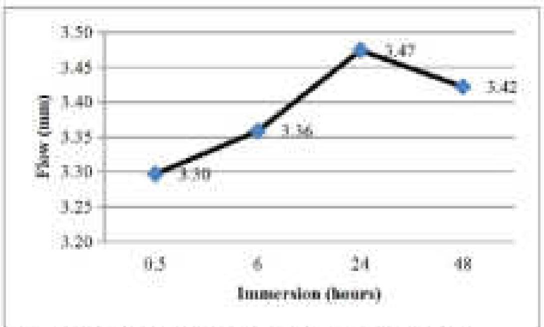

Figure 5. Graph of the Relationship between Flow and Immersion

From Figure 5 above, a mixture of asphalt concrete with 10% seashells waste still has a strong binding capacity even though it is soaked for 24 hours. The flow value at the 24-hour immersion is 3.47 mm. The flow value at 48 hours immersion is getting lower. This means that at 48 hours immersion, the concrete asphalt mixture begins to experience damage.

IV. Conclusion

Based on the results of the discussion some conclusions can be drawn, namely:

1. Variation of seashells waste in concrete asphalt mixture has a positive effect on the value of stability and flow.
2. The optimum percentage of seashells waste 10% produces Marshall stability value of 1364 kg and increases the value of Marshall stability by 36.752%.
3. The relationship between the variation of seashells waste to Marshall stability can be expressed by the equation: $Y = 997.43 + 61.19X - 2.45X^2$.
4. The optimum percentage of seashells waste 10% produces a flow value of 3,505 mm. With 10% seashells waste, an increase in flow value of 1.89%.
5. The relationship between seashells waste and flow is expressed by the equation : $Y = 3.44 + 0.02X - 0.001X^2$.
6. Variation of seashell waste with immersion has a negative effect on Marshall stability. The longer the immersion the lower the Marshall stability value. But instead for Flow, a mixture of asphalt concrete with 10% seashells waste, can withstand immersion for up to 24 hours. The flow value at the 24 hours immersion is 3.47 mm. While at 48 hours immersion, the flow value decreases. This means that the concrete asphalt mixture with 48 hours immersion begins to experience damage.

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References

[1] E. K. Resosudarmo, Budy P., "Illegal Fishing War: An Environmental Policy during the Jokowi Era?," *J. Southeast Asian Econ.*, vol. 35, no. 3, pp. 3[illegible]–385, 2018.

[2] Dr. Noel D. Binag, "powdered-shell-wastes-as-partial-substitute-for-masonry-cement-mortar-in-binder-tiles-and-bricks-production-IJERTV5IS070063.pdf," http://www.ijert.org ISSN: 2278-0181 IJERTV5IS070063, 2016.

[3] K. H. Mo, U. J. Alengaram, M. Z. Jumaat, S. C. Lee, W. I. Goh, and C. W. Yuen, "Recycling of seashell waste in concrete: A review," *Constr. Build. Mater.*, vol. 162, no. February, pp. 751–764, 2018.

[4] I. Garcia, E. Heras, F. Puertas, I. Oteiza, F. Martin-Consuegra, and J. J. Lagarra, "Tests on Mortars and Concrete Made With Seashells As Aggregate : Case Study in Mauritania," *11th Int. Conf. Non-conventional Mater. Technol.*, no. September, pp. 6–9, 2009.

[5] A. Maid, M. S. Pallu, N. A. Civil, and I. Ramli, "Experimental study the performance of asphalt concrete which using plastics powder filler in submersed water conditions," *Int. J. Civ. Eng. Technol.*, vol. 8, no. 7, pp. 686–696, 2017.

[6] E. Ahyudanari, J. J. Ekaputri, and M. Tardas, "Analysis of Coal Waste Solidification as an Alternative Filler Material in Asphalt Concrete Mixture," *Mater. Sci. Forum*, vol. 841, no. January 2016, pp. 65–71, 2016.

[7] N. M. Asmael, "Effect of Mineral Filler Type and Content Other Properties of Asphalt Concr.," vol. 16, no. 3, 2010.

[8] Y. Q. Tan and M. Guo, *Interfacial thickness and interaction between asphalt and mineral fillers*, vol. 47, 2013.

[9] S. Ibnu and U. Negroho, "Road Damage Analysis of Kalimak Road Surabaya," *Adv. Sci. Lett.*, vol. 21[illegible] 12, pp. 12295–12299, 2018.

[10] I. Sholichin and A. Ruminang, "Relation analysis of road damage with excessive vehicles load on Kalimak road Surabaya," *J. Phys. Conf. Ser.*, vol. 953, no. 1, 2018.

[11] M. K. Shamshuddin, M. E. Abdullah, and S. M. R. Shah, "Development of Moisture Sensitivity Test for Compacted Asphalt," *Int. J. Integr. Eng. (Issue Civ. Environ. Eng.*, 2010.

[12] M. R. Keymanesh, H. Ziari, A. Nasrollahtabar, and D. Kamrankho, "Correlation Between Aggregate to Aggregate Contact and Mechanical Properties of HMA Mixture," *Civ. Eng. Urban Plan. An Int. J.*, vol. 3,

no. 3, pp. [illegible]–35, 2016.

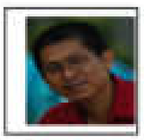
[13] N. Ali, "The Experimental Study on the Resistance of Asphalt Concrete with Butonic Bitumen againts Water Saturation," vol. 3, no. 5, pp. 508–516, 2013.

[14] E. Yener and S. Hınıslıoğlu, "Effects of exposure time and temperature in aging test on asphalt binder properties," *Int. J. Civ. Struct. Eng.*, vol. 5, no. [illegible], pp. 112–124, 2014.

[15] A. A. H. M., "Effect of Aggregate Gradation and Type on Hot Asphalt Concrete Mix Properties," vol. 42, no. 4, pp. 567–574, 2014.

[16] A. Setiawan, L. B. Suparma, and A. T. Mulyono, "The effect of aggregate gradation on workability of asphalt concrete," *Int. J. Eng. Technol.*, vol. 8, no. 4, pp. 1750–1757, [illegible].

[17] I. Sholichin and D. A. Sutama, "Variations in the Addition of Polypropylene Fiber, Fly Ash and Immersion in Asphalt Mixtures on Stability and Flow," *Int. J. Civ. Eng. Technol.*, vol. 10, no. 02, pp. 2032–2039, 2019.



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22 penerbit.uthm.edu.my
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Crossref
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24 Mohamad, Syed Burhanuddin Hilmi Syed, Zainal Abidin Akasah, and Mohammad Ashraf Abdul Rahman. "Factors Contributing to Building Maintenance Performance of Heritage Buildings", InCIEC 2013, 2014.
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