The effect of oil palm shell ash to asphalt characteristics

by Winsyahputra Ritonga

Journal of Physics: Conference Series

The effect of oil palm shell ash to asphalt characteristics

IOP Conf. Series: Journal of Physics: Conf. Series **1282** (2019) 012031 doi:10.1088/1742-6596/1282/1/012031

The effect of oil palm shell ash to asphalt characteristics

Winsyahputra Ritonga [1.a], Nila Yosefa Ritonga[1], Muhammad Aswin Rangkuti[1], Eddiyanto[2], Septian Prawijaya[3]

[1] Department of Physics, Medan State University, Medan, Indonesia
[2] Department of Chemistry, Medan State University, Medan, Indonesia
[3] Department of Elementary School Teacher Education, Medan State University, Medan, Indonesia

[a] Correspondence: winsyahputra@unimed.ac.id

Abstract. This study aims to determine the effect of the addition of oil palm shell ash on the characteristics of asphalt and its mixtures. Palm shell is chosen as a filler material due to its content of silicon dioxide (SiO2) so that it is used as a suitable binder. This study consisted of several stages: (1) making modified bitumen; (2) testing modified bitumen with asphalt physical requirements method; (3) making and testing specimens; (4) Marshall testing. The results showed that the addition of oil palm shell ash resulted in increased asphalt stability values with the highest stability of 1553 kg from sample 4. Furthermore, the addition of oil palm shell ash resulted in increased asphalt flow values with the highest flow of 3,85 mm from sample 5. Based on the results of the research and discussion, it was concluded that there was an effect of the addition of oil palm shell ash on the characteristics of asphalt and its mixture.

1. Introduction

Road damage is generally caused by loading that occurs excessively (overload) or caused by physical damage factor due to excessive flow of passing vehicles. The type of asphalt damage that often occurs is the release of granules and cracks so that it is effortless for the road to become hollow.

Various studies on the improvement of asphalt quality have been carried out such as the use of nanoclay [1], natural rubber [2,3,4] and research on various materials derived from rubber [5,6]. One of the causes of the low quality of asphalt is the presence of cavities in the mixture and aggregate to facilitate water into the mixture. The effect of water intake on the mixture causes the weaker asphalt and aggregate bonds which have an impact on the poor quality of asphalt [4,6].

To improve the quality of asphalt, a material that is capable of reducing the asphalt cavity and aggregate is needed. Reducing the cavity aims to increase the bond strength between the asphalt and the aggregate. Materials that are often used to increase the strength of asphalt bonds and aggregates are cement. However, other material alternatives need to be examined as a binder and filler in the mixture of asphalt and aggregate.

New material that can be used as asphalt modification material is palm shell ash. Palm shell ash is used as an alternative because it contains silicon dioxide (SiO_2) [7]. Silicon dioxide is the most abundant chemical element contained in portland cement and is suitable as a binder. The content of silicon dioxide will allow it to bind the asphalt and aggregate so that a stronger mix of asphalt is obtained, especially for the asphalt concrete wearing course

2. Methodology

This study used Pen type 80-100 asphalt. Asphalt was modified by adding cyclic natural rubber (CNR), acrylic acid and benzoyl peroxide. The mixture of asphalt and other ingredients was stirred into homogeneous with a temperature of 90^{o}C for 60 minutes and a rotating speed of 180 rpm. The composition of asphalt mixture and modification material is described as follows:

Table 1. Modified Asphalt Mixture Composition

Sample	Asphalt (g)	CNR (g)	Acrylate Acid (ml)	BPO (gr)
1	2000	0	0	0
2	2000	20	5	0,336
3	2000	40	5	0,336
4	2000	60	5	0,336
5	2000	80	5	0,336

To find out whether the origin was suitable for use as research material, modified asphalt was tested for physical requirements with penetration test, softening point test and density test. After testing the physical requirements of the asphalt, the test object was then made and then making test specimens which mean asphalt is mixing with aggregates and palm shell ash. The specimen consisted of coarse aggregate and soft aggregate with a mass of 1.2 kg. For test specimens, oil palm shell ash was added as much as 1% of the aggregate mass. Five test pieces were made by many modified bitumen samples.

3. Results and Discussion

3.1. Testing of Asphalt Physical Properties

The asphalt used as the research sample is Pen type (80-100) asphalt for sample 1 and modified asphalt for samples 2,3,4 and 5. The results of testing the physical requirements for asphalt are as follows:

Table 2. Asphalt Physical Requirements Testing Results

No	Type of Test	Unit	Sample					Standard
			1	2	3	4	5	
1	Penetration	mm	98,50	155,4	138,9	121,8	110,9	80-99
2	Softening Point	^{0}C	44,5	43,5	42,5	41,5	40	40-55
3	Density	% berat	1,0318	,0435	1,0375	1,0259	1	Min 1,0

The test results data in table 2 shows the overall aspects of physical requirements in sample 1 (pure asphalt) reaching the standards that have been set and deserve to be used as research samples. The results of testing the physical requirements of modified asphalt showed that the cyclic natural rubber concentration on asphalt caused the penetration of asphalt to be lower, the softening point became smaller, and the asphalt density was lower. Test the physical requirements of asphalt can be explained in figures below

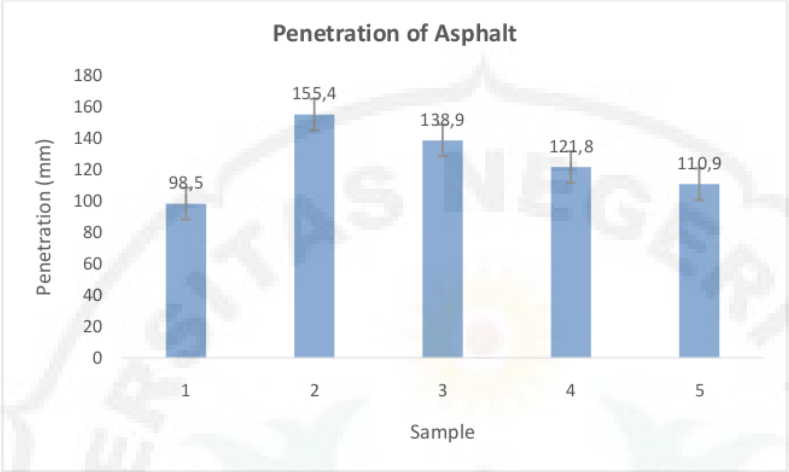

Figure 1. Physical Requirements for Penetration of Asphalt

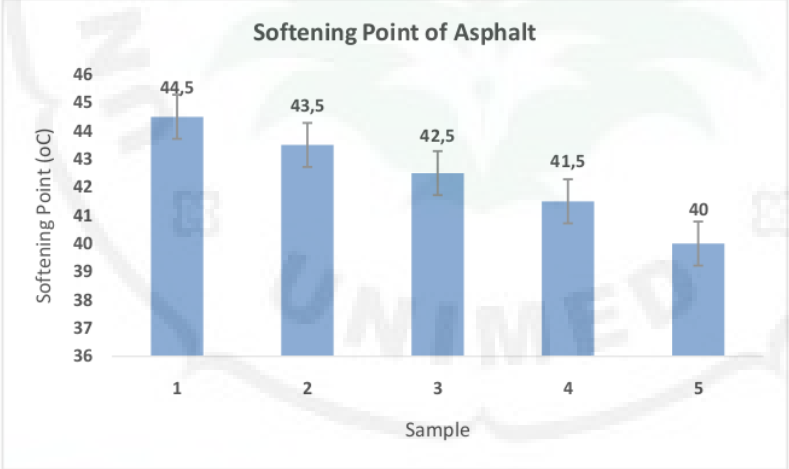

Figure 2. Physical Requirements for Softening Point of Asphalt

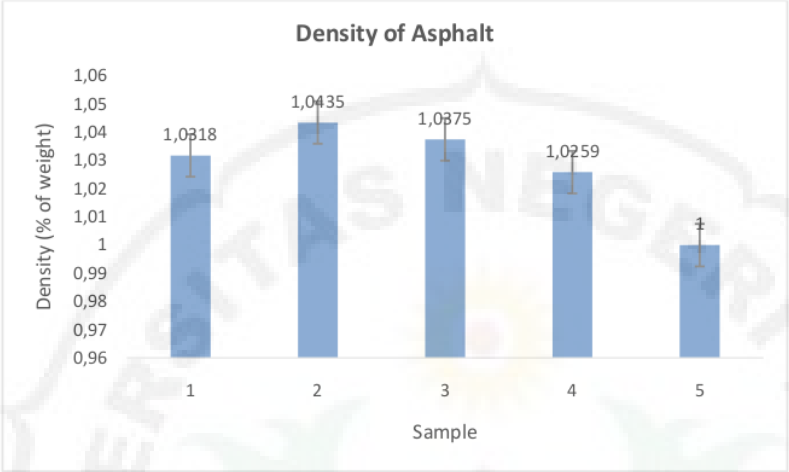

Figure 3. Physical Requirements for Density of Asphalt

3.2. Stability of modified asphalt mixture

Stability checks are needed to measure the resistance of the test object to the load and get the hottest temperature in the field, so before the examination, the sample was heated first for 30 or 40 minutes with a temperature of 60^0C in a water bath. The measurement was done by placing the test object on the Marshall tool, and the load was applied to the test object at a speed of 2 inches/minute or 51 mm/minute. The load at the time of collapse was read on the measurement watch on the proving ring. The stability value was the value of the measuring watch multiplied by the proving ring calibration and corrected by the correction number due to variations in height or volume of the sample.

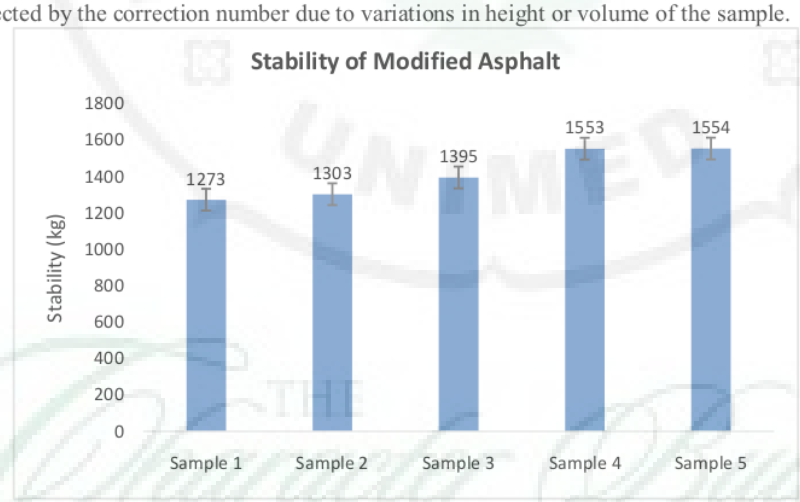

Figure 4. The Relationship Between The Stability Value Of Modified Bitumen And Palm Shell Ash

3.3. The Flow Value of Asphalt Modified

Flow values can be read by flowmeter using the value of the proving ring measuring watch and measured at the time of the collapse. Flow values were used to measure deformations that occur due to

loads. The results of the effect of testing the variation of added material and asphalt content on the flow were presented in Figure 5.

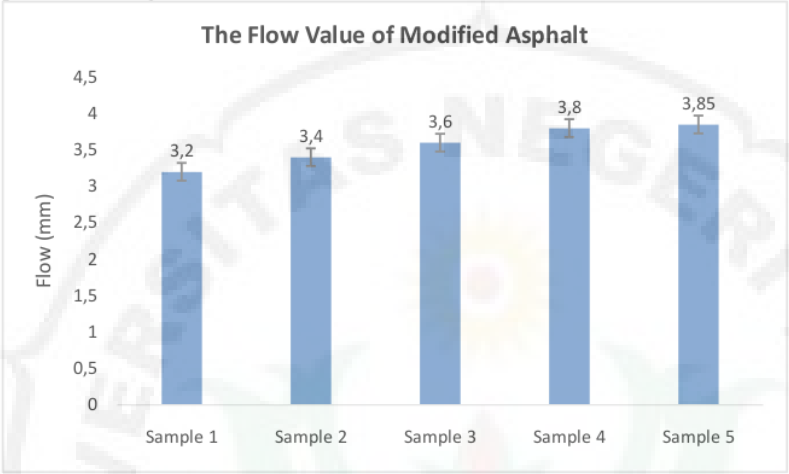

Figure 5. The Relationship Between Modified Bitumen Flow Values And Palm Shell Ash

3.4. Discussion

3.4.1. Asphalt Physical Properties Requirements

From the test results, the addition of CNR, Acrylate Acid and Benzoyl Peroxide on asphalt Shell pen 80-100 affected the physical properties of asphalt. Addition of CNR in modified bitumen increased penetration in sample 2 and decreases in sample 3, sample 4 and sample 5 (Figure 1). The drop in penetration means that the asphalt became harder. Addition of CNR also resulted in decreasing asphalt softening points. Thus the addition of CNR decreased the penetration value and decreased the softening point value. It was understandable that the addition of CNR, Acrylate Acid and Benzoyl peroxide affects the bond between asphalt and CNR due to the addition of benzoyl peroxide and acrylic acid as a compatibilizer to combine asphalt with CNR. Modification of asphalt with polymers can improve the properties of the asphalt. This was possible because there was an interaction between asphalt and polymer in the mixture so that the bond can both improve the quality of asphalt [8].

The addition of CNR as an added ingredient also influences the value of the specific gravity of asphalt. Addition of CNR decreased the value of specific gravity. Specifically, the addition of 80 g of specific weight CNR has the lowest value of 0.9346 (Figure 1). The low-density value was caused by the combination of both soft points with 50^{o}C pure asphalt softening point and CNR 150^{0}C softening point, the combination of softening points both causes the mixed density to change.

3.4.2. Testing Asphalt Characteristics

The quality of the asphalt mixture can be seen from the effect of material variations added to asphalt on Marshall properties including the value of Stability and Flow. The addition of palm shell ash to modified asphalt affects the stability value (Figure 2). Modified asphalt mixture with palm shell ash reached the maximum state of CNR 80 g addition. This was due to a decrease in penetration value because asphalt which has a low penetration value is a blown grade bitumen. To be able to withstand large loads, blown grade bitumen was required to experience an optimum stability value in the asphalt content of 6% of the total modified asphalt mixture [9]. Therefore, the smaller the penetration value, the higher the value of stability. Also, CNR can increase the bond between asphalt and aggregate for the better. The addition of palm shell ash to modified asphalt affected the value of flow (Figure 3). The test results showed that the highest flow value is shown at 80 g CNR.

Moreover, the value of density was contradicted with the flow and stability test. This was because the addition of CNR made the asphalt structure change. Judging from the elements found in the palm shell ash asphalt, these elements are related to the asphalt element so that it supports the improvement of asphalt quality. Moreover, the results of this study can be used on concrete asphalt (asbuton) because most silicon elements are used on concrete asphalt.

4. Conclusion

From the results and discussion of the study, it was concluded that the addition of palm shell ash waste affected the characteristics of modified asphalt. The optimal effect is obtained by adding 80 g of cyclic natural rubber.

Acknowledgments

The researcher would like to extend his gratitude to the Ministry of Research, Technology and Higher Education for funding this research under the schema of Penelitian Strategis Nasional Institusi 2018.

Reference

[1] You Z., Mills-Beale J, Foley J M., Roy S, Odegard G M, Dai Q and Goh S W, 2011 *Construction and Building Materials* **25**(2) 1072-1078
[2] Oliveira J R., Silva H M, Abreu L P and Fernandes S R 2013 *Journal of Cleaner Production* **41** 15-22
[3] Liu Y, Sen H, Zhongjie Z and Ouming X 2012 Design and evaluation of gap-graded asphalt rubber mixtures *Materials & Design* **35** (2012) 873-877
[4] Partl M N, Pasquini E, Canestrari F and Virgili A, 2010 *Construction and Building Materials* **24**(3), 283-29
[5] Cetin A 2013 Effects of crumb rubber size and concentration on performance of porous asphalt mixtures *International Journal of Polymer Science*
[6] Ritonga W and Irfandi I 2016. Pengaruh Karet Alam Siklik (Cyclic Natural Rubber) Terhadap Rongga Aspal Modifikasi. *Jurnal Pendidikan Fisika Indonesia*, **12**(2) 169-176
[7] Chaivatamaset P, Sricharoon P and Tia S 2011 *Applied Thermal Engineering* **31**(14-15) .2916-2927
[8] Rianung S 2007 Kajian Laboratorium Pengaruh Bahan Tambah Gondorukem pada Asphalt Concrete-Binder Course (AC-BC) Tehadap Nilai Propertis Marshall dan Durabilitas*, Tesis Program Pascasarjana Fakultas Teknik Universitas Diponegoro* (Semarang: Universitas Diponegoro)
[9] Ritonga W 2013 Modifikasi Aspal dengan Menggunakan Karet Alam Siklik (*Cyclic Natural Rubber*) *Tesis Magister Ilmu Fisika FMIPA* (Medan: Universitas Sumatera Utara)

The effect of oil palm shell ash to asphalt characteristics

ORIGINALITY REPORT

3%	4%	2%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	umpir.ump.edu.my Internet Source	2%
2	Submitted to Universitas Negeri Surabaya The State University of Surabaya Student Paper	1%
3	pertambangan.fst.uinjkt.ac.id Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		