UNTAR
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3rd International Conference on Engineering of Tarumanagara

"SMART ENGINEERING FOR FUTURE CITIES"

Jakarta, 04-05 October 2017

PROCEEDING

FACULTY OF ENGINEERING
TARUMANAGARA UNIVERSITY
Main Building, Campus I, Jl. Letjen S. Parman No 1, Jakarta Barat
Jakarta 11440 - Indonesia

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Tarumanagara University

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Editor:
Dr. Eng. Titin Fatimah, S.T., M.Eng
Dr. Steven Darmawan, S.T., M.T.
Meirista Wulandari, S.T., M.Eng.

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ICET 2017
CONFERENCE PROGRAM

Day 1: Wednesday, October 4th, 2017

	Time	Activity
1	08.00-08.30	Registration + coffee break
2	08.30-09.30	Opening ceremony - Opening remarks from ICET 2017 chairperson - Opening remarks from the Dean of Engineering Faculty - Opening remarks from the Rector of Universitas Tarumanagara
3	09.30-12.00	Keynote Speaker I Prof. Dr. Stephen Cairns, Program Director od the Future Cities Laboratory, ETH Zurich *“Urban Transformations in Asia: Responsive Knowledge Strategies, Design Scenario, and Action Plans”*
		Keynote Speaker II Prof. Dr. Tech. Ir. Danang Parikesit, M.Sc. (Professor of Transportation Planning and Engineering UGM, Chair – Transportation Technical Committee, National Research Council) *“Updates on The Progress of Intelligent Transportation System for Indonesian Urban Areas”*
		Discussion (moderator: Dr. Danang Priatmodjo)
4	12.00-13.00	Lunch break
5	13.00-15.00	Parallel session I
6	15.00-15.15	Coffee break
7	15.15-17.00	Parallel session II

Day 2: Thursday, October5th, 2017

	Time	Activity
1	08.00-08.30	Registration + coffee break
2	08.30-10.30	Parallel session III
3	10.30-10.45	Coffee break
4	10.45-12.15	Parallel session IV
5	12.15-12.30	Closing
6	12.30-end	Lunch break

Note :
- Opening ceremony and plenary session: Main Building, Auditorium 3rd floor
- Parallel session: Main Building, 14th floor

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EFFECT OF MIXING TEMPERATURE ON ASPHALT CHARACTERISTIC OF CONCRETE USING HIGH DENSITY POLYETHYLENE (HDPE) AS PARTIAL SUBSTITUTION OF FINE AGGREGATE

Ir. Ni Luh Putu Shinta Eka Setyarini, M.T[1)], Dr. Widodo Kushartomo, S.Si, M.Si[2)], Erland Ferrary Arius Ambon[3)]

Civil Engineering Tarumanagara University, Letjen S. Parman No.1, Jakarta, 11440, Indonesia

e-mail: shintarachmat@yahoo.com

Abstract

The Asphalt Concrete (LASTON) is a part of highway construction consisting ,a mixture, asphalt and aggregate that is continuous graded, mixed, spread, and compacted in a hot state at a certain temperature. Prime material of LASTON is aggregate. Since aggregate is a non-renewable material, fine aggregates retained in sieve number 8 are replaced with HDPE plastic waste 25 %. Before being used as a pavement mixed material, this HDPE plastic waste will go through the process of smelting, printed and then broken into pellet form by using a crusher machine. The good quality of construction material indicates by durability,influenced by stability and flow value. To Get a good stability and flow value, mixing temperature becomes important to note. The mixing temperature is the temperature of asphalt and aggregate when mixed. There are 3 mixing temperatures to be used in this study, such as, temperatures of 160 ° C, 170 ° C, and 180 ° C. It aims to get the right mixing temperature for LASTON mixing with HDPE plastic. The results showed that the mixing temperature having good stability and flow value was 180 ° C mixing temperature.

Keywords: *LASTON, HDPE plastic, mixing temperature.*

1. INTRODUCTION

Road is the land transportation infrastructure, an important element to facilitate the mobility of goods and people. Thus, the material of road pavement construction must be considered well. Natural aggregates that are often used for flexible pavement construction materials are non-renewable raw materials. One alternative of the natural aggregate substitute is plastic. With the increasing use of plastic materials and the lack of recycling processes, will be an increase in the amount of plastic waste in nature is very difficult to decompose. The use of plastics as replacement of aggregates can be a solution to both problems.

Plastics used as material replacement of fine aggregate which is the pavement material mixtures. The fine aggregate is replaced with High Density Polyethylene (HDPE) plastic waste type. HDPE plastic waste is a high density polyethylene type so it is resistant to heat, cold, water, weather, and scratches, and is an excellent insulator material (Schwarz, 1986) Before used as a pavement mixed material, this HDPE plastic waste will go through a smelting process, printed and then broken into pellet form using a crusher machine.

In the pavement implementation, the compaction temperature of LASTON mixture with HDPE plastic waste is very influential to the characteristics of the planned asphalt concrete . At the time of mixing the amount of collision and temperature in the compaction of the mixture is very influential on the characteristics of the mixture. The hot asphalt mixture for flexible pavement is designed using the Marshall method. The values taken from the Marshall test are the stability values obtained from the load required until sample failures, and the flow values by measuring the vertical distortions required until become sample failures (Tajudin, 2013)[2].

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According to Rahmawati (2015)[3], use of HDPE plastics waste has an effect, on the LASTON mixture on various Marshall characteristics i.e. for stability, Flow,and VFWA values which tend to increase. The effect of HDPE plastic waste mixture as a substitute for fine aggregates gives better Marshall characteristic values.

It is expected that partial replacement of aggregates with HDPE plastics waste and at certain temperature mixing processes can extend the life of the plan and improve the quality of the pavement mixture.

Purpose and objectives

The aim of this research is to know the effect of mixing temperature on concrete asphalt characteristic (LASTON) by using plastic (HDPE) as substitute of fine aggregate, through Marshall method.

Formulation of problem

Some research problems are formulated as follows:
Determinated the mixing temperature to the characteristics of the asphalt concrete with the addition of HDPE plastic.
What is the value of stability, Flow, and Voids in The Mix (VITM)?

Scope of problem

This study was conducted by limiting the problem only to the effect of mixing temperature on the characteristics of asphalt concrete with the addition of HDPE plastic waste as a substitute for fine aggregate. The study was conducted by collecting several journals as theoretical material, and then perform experiments in the laboratory using the Marshall Test method.

2. RESEARCH METHODS

Preparation

At this stage the material is collected according to the specifications and the tools used to test the sample. The materials used are asphalt, aggregate, and HDPE plastic waste. The equipments used are from Tarumanagara University highway laboratory properties. Material testing shows that aggregates, asphalt and HDPE plastic waste seeds meet the specifications.

Manufacture of test objects

The number of test specimens that will be made to find the Optimum Asphalt Level (KAO) is 36 samples. 36 samples consist of 9 specimens for conventional pavement mix and 27 specimens for modified pavement mixture. The first step of making conventional pavement blends is to make 9 samples using asphalt content of 4%, 5%, and 6%, with standard mixing temperatures (160 °C). The sample number of the modified pavement mixture was 27 samples using mixing temperatures of 160 °C, 170 °C, and 180 °C. Bitumen content used 4%, 5%, and 6%. The following is the procedure for making the test object:

1. Aggregate that is suitable for gradation (job mix design) heated to 160 °C for mixing temperature of 160 °C, for temperature mixing 170 °C heated to 170 °C, and for mixing temperature 180 °C heated up to 180 °C. Likewise with asphalt, it must be heated according to the required mixing temperature.

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2. Once the aggregate and the asphalt have reached the required mixing temperature, pour the asphalt into the aggregate. This pouring should use the scales, in order to obtain the required bitumen percentage.
3. Mix the asphalt and aggregate until the asphalt envelopes the aggregate surface evenly. Mixing is done on the stove, in order to keep the mixing temperature not decreasing.
4. Apply oil or oil to a preheated mold. Then pour the aggregate mixture and asphalt into the mold.
5. The test specimens from the top and bottom sides, each with 75 times the collision. The number of these collisions is in accordance with the Bina Marga's 2010 Mine Specification requirements for the LASTON AC-BC mixture.
6. After finish the compaction process, leave the specimen until the temperature falls to room temperature (25 °C). This matter carried out in order to facilitate the removal of the test specimen from the mold.

Marshall Testing

This Marshall test purpose to determine the resistance (stability) to the plastic melt (flow) of the asphalt mixture. Marshall tests include checks for stability, flow and calculation of density values, Voids In Mix (VIM), and Voids Filled Bitumen (VFB). From result of evaluation of value and regression analysis hence obtained as Optimum Asphalt Level (KAO).

The tool used is mold, standard crusher, ejector, Marshall test equipment complete with dial stability and flow, soaking tub (Water bath), thermometer,scales, oven and the other else.

Marshall tests on conventional pavement blends (plastic content of 0%) and modification (25% plastic content) were performed with the purpose of obtaining Optimum Asphalt (KAO). KAO is obtained by looking at Marshall parameters. If there is a result of asphalt content that does not meet the specifications, it will be used the level of asphalt that gives the results closest to the specification, or so-called condition of asphalt content near the optimum.

The following is the ordinance in testing the specimen by using Marshall method:

1. The specimen that is in accordance with the temperature of the room, removed from the mold using ejector.
2. Clean the specimens from the dirt.
3. Put an identifier on each specimen.
4. Measure the height of the specimen with accuracy of 0.1 mm.
5. Weigh the specimens, to get the dry weight.
6. Soak the specimen into the water at 25 °C for about 24 hours.
7. Weigh the test object into water to get the weight of the contents.
8. Weigh the test specimens in the dry state of the saturated surface.
9. Soak the specimens into the water bath for 30 minutes at 60 ± 1 °C, and prepare the Marshall mechine.
10. Prepare stability and flow watches. The installation of the flow watch should not touch the proving ring, this is done to obtain optimal flow results.
11. Press the specimen, record the stability, and the flow value at the time of maximum loading.
12. The time required when lifting the specimen from the water bath until it reaches the maximum load shall not exceed 30 seconds.

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3. DATA ANALYSIS

Results Comparison of Mixing Temperature (160 °C, 170 °C, and 180 °C) Plastic Content 25%

3.1. Density

Viewed from the graph below(Figure 1), it can be concluded that the higher the mixing temperature the density of the specimen will decrease. This is because at high mixing temperature HDPE plastic has decreased quality, because HDPE plastic is too melting.

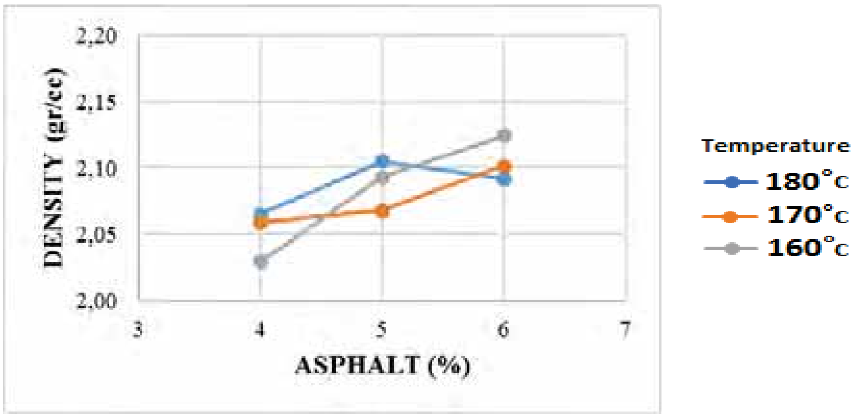

Fig.1.Density - Asphalt Relation, Plastic Content 25% and mixing temperature 160 °C, 170 °C, and 180 °C

3.2. Effect of Mixing Temperature Variation Against Mixed Cavity

The mixing temperature variation will affect the mixed cavity condition along with the difference in the density of the specimen. The mixed cavity parameters studied were cavities in mixed / Void In Mix (VIM), Void Filled With Asphalt (VFWA) cavities, and voids in aggregate minerals / Void in Mineral Aggregates (VMA). See at Figure 2.

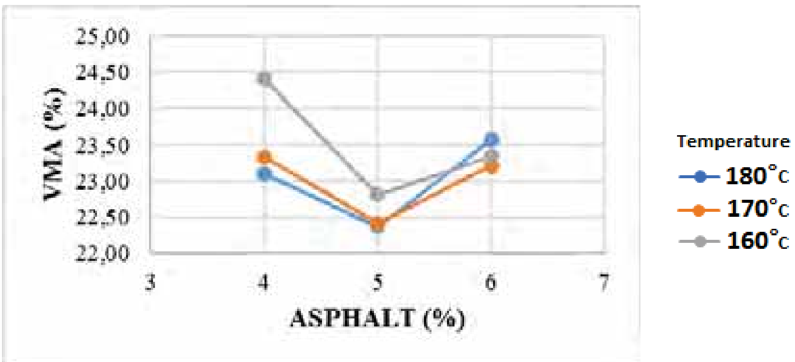

Fig.2. VMA - Asphalt Relation , Plastic Content 25% , and mixing temperature 160 ° C, 170 ° C, and 180 ° C

The value of VMA will decrease along with the addition of bitumen content, then will rise again at a certain point of asphalt content (Sentosa, 2013)[4]. At mixing temperature of 160 °C, 170 °C, and 180 °C there was a decrease of VMA value from 4% to 5% asphalt level, and increased again at 6% asphalt content.

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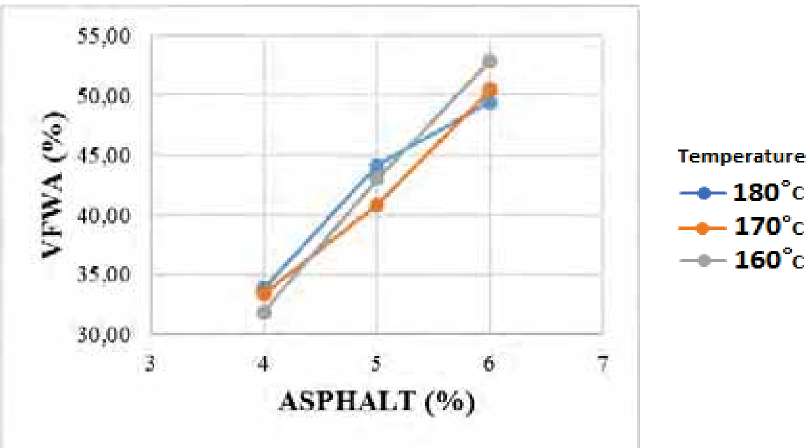

Fig.3. VFWA -Asphalt Relation , Plastic Content25%. and mixing temperature 160 °C, 170 °C, and 180 °C

The decrease of VITM and VMA values based on mixing temperature is inversely proportional to VFWA. The higher the asphalt viscosity mixing temperature the smaller and easier it will be to enter the cavity inside the mixture. So the VFWA value is getting bigger, in other words the more cavities are filled by asphalt. As shown by the graph in Figure 3.

3.3. *Effect of Temperature Blending Variation on Stability and Flow*

It is generally seen that the effect of mixing temperature variation on stability value has an increasing trend. In the mixing temperature variation of 160 °C the stability value obtained is lower than the stability value for other mixing temperature variations. Stability will increase with increasing mixing temperatures.

In the graph flow shows the highest flow value is at a temperature of 160 °C, and the lowest is at a temperature of 180 °C. If the mixing temperature continues to be increased then the flow value will continue to decrease.

From Figure 4. it can be seen that the stability value has increased. This is due to the penetration value on the asphalt concrete mixture becomes low with the addition of HDPE plastic seed. The HDPE plastic seed will melt when heated, so it will fill the cavities inside the asphalt concrete pavement mixture. A low penetration value will cause an increase in the value of stability.

From Figure 5. Visible increase in flow value. Flow shows deformation of test object due to loading. The value of flow is influenced by several factors such as gradation, asphalt content, and aggregate surface shape. The HDPE Plastic seeds cause the asphalt concrete pavement mixture to become thickened. At a mixing temperature of 170 °C, the most optimum level of HDPE plastic seed density, so the flow value at the lowest 170 °C mixing temperature.

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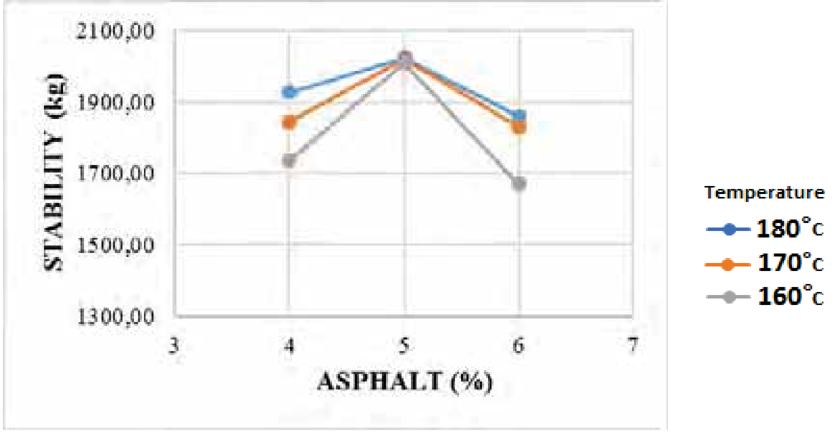

Fig.4. Stability Relation with Asphalt 25% Plastic Content mixing temperature 160 °C, 170 °C, and 180 °C

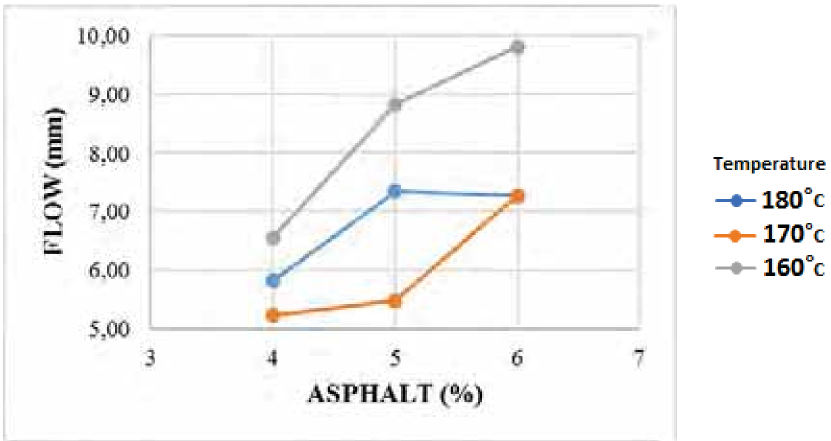

Fig.5. Flow Relation with Asphalt 25% Plastic Content mixing temperature 160 °C, 170 °C, and 180 °C

3.4. Marshall Testing On Asphalt Conditions Condition Approaching Optimum

The determination of KAO values using parameters based on the Bina Marga Specification (2010) [5] are VMA, VITM, VFWA, stability, and flow. Of the 5 parameters the VFWA and VITM values do not meet the specifications, so asphalt content is taken close to the optimum. Asphalt level approaching optimum used is 6%. So, no need to create a new test object.

The following is a graph of the pavement mixture using the optimum bitumen content, the plastic content of 0%, and the mixing temperature of 160 °C. Marshall parameters that will be compared with pavement mix using 25% plastic content are stability and flow.

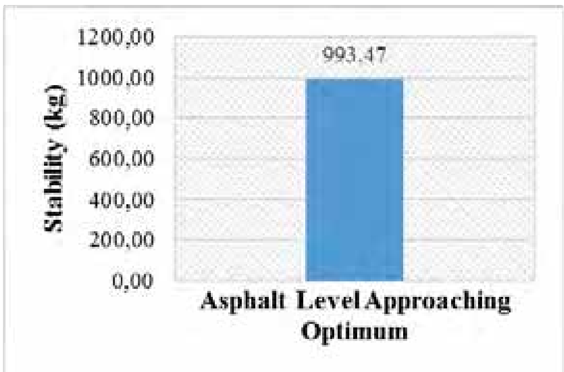

Fig.6.Stability-Asphalt Approaching Optimum Plastic Content 0% Temperature Mix 160 °C

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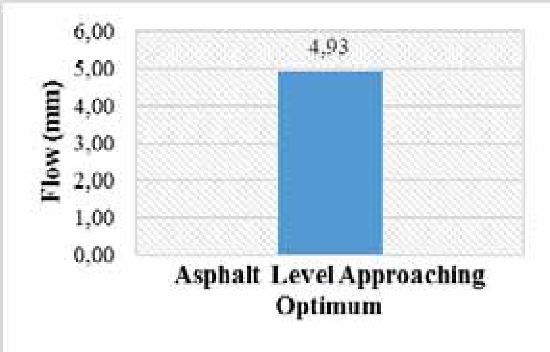

Fig.7. Flow-Asphalt Approaching Optimum Plastic Content 0% Temperature Mix 160 °C

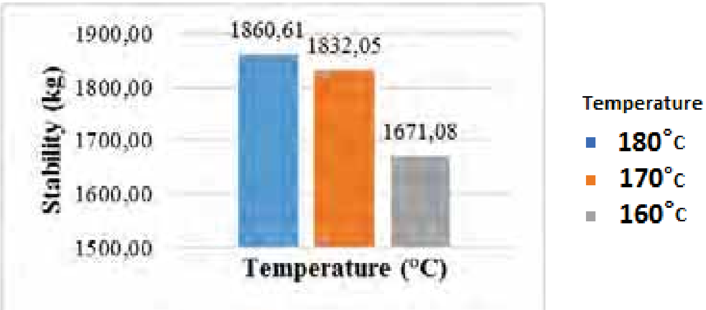

Fig.8. Asphalt Stability Near Optimum 25% Plastic Content Temperature mixing 160 °C, 170 °C, and 180 °C

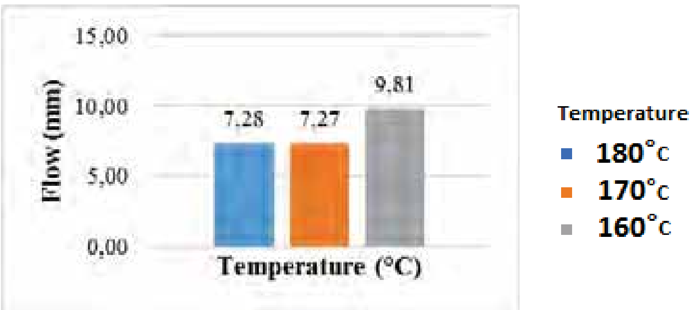

Fig.9. Flow Asphalt Level Approaching Optimum 25% Plastic Content Temperature mixing 160 °C, 170 °C, and 180 °C

From the comparison of the above graph can be seen that the stability and flow of asphalt concrete pavement mix will increase if added HDPE plastic waste seed.

Stability values are used as parameters to measure resistance to plastic melting of a mixture of asphalt concrete, or the ability of a mixture of asphalt concrete to withstand deformation occurring due to traffic load. The increased stability value is caused by the melting of HDPE plasticwaste seeds when heated, resulting in many cavities within the pavement mixture filled by HDPE plastic seeds. The 180 °C mixing temperature provides the best performance in improving stability.

Increased flow value is caused by the use of HDPE plastic waste seeds in asphalt concrete pavement mixtures. The use of HDPE plastic waste seeds causes the thickening of asphalt concrete pavement mixture, which is why the flow value increases when using HDPE plastic seeds in asphalt pavement mixtures. From Figure 10. the mixing temperature of 180 °C indicates a not too low flow, if the flow is too low the pavement mixture becomes stiff or brittle.

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Thus it can be concluded that 180 °C mixing temperature provides the best performance on asphalt concrete pavement mix with HDPE plastic waste seed.

4. CONCLUSIONS

Based on the results of laboratory research and data analysis, the following conclusions can be drawn:

1. Addition of HDPE plastic waste content and mixing temperature increase in asphalt concrete layer can increase stability and flow value.
2. VITM value of asphalt content will decrease along with addition of bitumen content. Because the asphalt fills the cavities inside the mixture.
3. At mixing temperature of 160 °C, 170 °C, and 180 °C there is a decrease of VMA value from 4% to 5% asphalt level, and again increase at 6% asphalt level.
4. The higher the asphalt viscosity mixing temperature the smaller and easier it is to enter the cavity inside the mixture. So the VFWA value is getting bigger, or in other words the more cavities are filled by asphalt.
5. The optimum bitumen content obtained is 6%, because at 6% asphalt level Marshall parameter closest to Specification Bina Marga Year 2010 about hot paved mixture. This condition is called asphalt content approaching optimum.
6. Increased stability value is caused by melting of HDPE plastic waste seeds when heated, resulting in many cavities within the pavement mixture filled by HDPE plasticwaste seeds. The 180 °C mixing temperature provides the best performance in increasing the stability value.
7. Flow will increase if added HDPE plastic waste seeds, this is due to asphalt concrete pavement mixture increased flexibility. The mixing temperature of 180 °C indicates the flow is not too low, if the flow is too low then the pavement mixture will become stiff or brittle.
8. The mixing temperature which gives the best performance for Asphalt Concrete Base (LASTON) mixture with HDPE plastic is 180 °C. 9. By using 25% plastic waste in the mixture, it can reduce 1.7 tons of plastic waste per 1 km of road.

SUGGESTION

Suggestions that can be given to further research are:

1. To find the value of optimum asphalt content, should be very concerned about the percentage selection of asphalt content. Researchers recommend using percentage of 5%, 6%, and 7% asphalt content.
2. At the time of mixing the asphalt and aggregate, the researcher advises to always measure its temperature.
3. When aggregate heats, aggregate should always be stirred.

REFERENCES

[1] AASHTO (1978).Standar Specification For Transportation Materials and Methods of Sampling And Testing , Part I (Method Of Sampling And Testing)

[2] Tajudin, Noor Annisa. 2014. Utilization of HDPE Plastic Lifes Aggregate Substitute on Asphalt Concrete-Binder Course (AC-BC). Yogyakarta: Department of Civil and Environmental Engineering Faculty of Engineering GadjahMada University.

[3] Rahmawati, Anita; Rosyada, Amrina Maryam; Nega, Pepi. 2015. Comparison of the Effect of Addition of High Density Polyethylene Plastics (HDPE) In LASTON-WC and LATASTON-WC Against Marshall Characteristics. Yogyakarta: Department of Civil Engineering Faculty of Engineering University of Muhammadiyah Yogyakarta.

ISBN: 978-602-71459-8-6

[4] Sentosa, Leo.2013. Pengaruh Variasi Suhu Pencampuran dan Pemadatan Campuran Beraspal Panas Menggunakan Aspal Retona Blend 55. Riau : Department of Civil Engineering Faculty of Engineering Riau University.
[5] Division 6. 2010. General Specification of Asphalt Pavement (Revision 3). Jakarta: Bina Marga