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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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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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CHARACTERISRIC OF ASPHALT CONCRETE MIXTURE USING LOW DENSITY POLYETHYLENE (LDPE) WASTE AS PARTIAL SUBSTITUTION OF FINE AGGREGATE

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Abstract

Asphalt layer is a part of highway construction consisting a mixture of asphalt and aggregate that consist of well graded gradation, mixed, spreading and compacted in a certain hot steady temperature. The value of Stability will be effect to durability, to increase asphalt concrete mixture stability can be used LDPE plastics waste as a substitute of fine aggregate. The LDPE plastics waste in this study were pellet-shaped with a retained size in sieve no.8, the LDPE plastic waste content used is 25% of the total volume aggregate retained in sieve no.8. The specimens are cylinders with a diameter of 4 inch and a thickness of 2.7 inch. Marshall testing with the addition of LDPE wasted plastic can increase the stability by 4.867%

Keywords: *LASTON, Plastic LDPE waste, Marshall test*

1. INTRODUCTION

In era of globalization, requires rapid access to achieve a destination. Therefore, transportation is one of the important elements where ever human needed. Transportation has 2 important components which is facilities and infrastructure. Road is the land transportation infrastructure is one urgently element in the effort to facilitate the mobility of goods or services to the economic growth. To achieve that, land transportation infrastructure cannot be separated from the availability of the materials for road pavement. Natural aggregates that are often used for pavement construction are non-renewable raw materials in the long run and their availability will be exhausted. Therefore we need a substitute material to replace the natural aggregate usage in pavement construction.

This research is to know the effect of substitution of fine aggregate that is replaced by Low Density Polyethylene (LDPE) plastic waste will effect the performance of asphalt concrete mixture. Utilization of LDPE plastic waste as an added material is expected to change the physical properties of asphalt concrete mixture, improve stability and mixed resistance to deformation. There are seven characteristics of the mixture that must be possessed by asphalt concrete is: stability, durability, flexibility, fatique resistance, skid resistance, waterproof and workability. (Sukirman Silvia. 2003)[1]

A way to increase the softening point of asphalt is to add plastic, in this research we use Low Density Polyethylene (LDPE). (Suroso Wasiah Tjitjik. 2009)[2] This study is expected to provide a characteristic value of pavement with Marshall Test when used LDPE Plastic waste as a substitute for fine aggregate. Therefore becoming the answer to minimize resource depletion, environmental degradation, and energy consumption caused either from the waste itself or from aggregate excavation process.

The purpose and objectives is to determine the optimum asphalt content of asphalt mixture with additional LDPE plastic waste and determined the influence of LDPE plastic waste on the characteristics of marshall paved mixture.

Formulation of the problem, use of good meterial is the first step in the success of the constituency of roadblock to obtain service age according to plan. To obtain a longer usage life then roads can be designed with the involvement of certain substitute materials.

The availability of aggregates in nature is a material that cannot be compromised and may someday be exhausted. Hence the utilization of LDPE Plastics. In concrete asphalt mixtures can be an alternative in road construction.

Some of the problems that exist in this research about the use of LDPE plastic can be used to improve Characteristic of concrete asphalt mixture and asphalt stability value with and manufacture with substitution of fine aggregate with plastic more efficient than conventional concrete asphalt

The problem of this study is limited only to the characteristic of concrete asphalt mixture. By using LDPE plastic as a substitute for fine aggregate. This thesis is done with research in the laboratory by conducting marshall experiments, Collection theory is from the journal as reference.

2 RESEARCH METHOD

LASTON is a surface layer of pavement construction that has a structural value. This mixture comprises a continuous graded aggregate with hard asphalt, mixed, overlayed and compacted in a hot state at a certain temperature. It consists of a mixture of hard and aggregate asphalt which has a continuous gradation, mixed, spreaded and solidified at a certain temperature. (Sukirman Silvia. 2012.) [3]

LASTON as a binding layer, known as AC-BC (Asphalt Concrete - Binder Course) with a minimum thickness of AC-BC is 5 cm. This layer to form the foundation layer if used on road improvement or maintenance work.

The plastic LDPE waste used in this study serves as a partial replacement for the aggregates used. Tests conducted in this study using guidelines from DGH 2010 Division 6 revision 3.[4] Stages of research follow the steps as follows:

1. *Preparation Stage*
   Preparation of materials includes activities procurement of materials to be used in research. The materials used in this research include coarse aggregate, fine aggregate, asphalt and LDPE plastic waste. Rough and fine aggregates are obtained from Serang area, while for LDPE plastics waste are obtained from Dadap-Cengkareng, West Jakarta. The tools used for the testing of coarse aggregates, fine aggregates, asphalt and plastic seeds, as well as marshall test objects shall be in a clean and well-calibrated condition.
2. *Material Test*
   The materials used in this research consist of coarse aggregate, fine aggregate, asphalt and LDPE plastics firstly tested in accordance with the test method used. As for LDPE plastic waste testing includes specific gravity and sieve analysis.
3. *Job Mix Design*
   The asphalt level approaches the optimum used by 6% of the total weight of aggregate (1100 grams) or as much as 66 grams. Plastic content is planned at 25%
4. *Establishment of Speciment*
   At this stage the aggregate is weighed according to the gradation plan of each sieve number or fraction. Then the aggregate is heated to 165 ° C, then the weighed plastic is mixed into the frying pan. The aggregate being heated and stirred until evenly mixed, after which it is mixed with hot asphalt and then stirred again until evenly distributed.

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Then the mixture is put into the mold to be pounded as much as 2 × 75 times. The test specimen is made of three (3) pieces for each bitumen content

5. *Testing of the Specimen***.**
   Testing of the specimen using a Marshall Test tool. A Marshall Test tool is a press device equipped with a proving ring used to measure the stability and flow meter values used to measure flow.

3. RESULTS AND DISCUSSION

For starters in this research, material testing that will be used includes examination of physical characteristics of materials, aggregates, asphalt and waste plastic seeds. This test is necessary to determine whether the type of aggregate, asphalt, and plastic waste seeds used are of good quality or not (meet specifications or not).

This test is performed in accordance with the existing test guidelines and is also supported with calibrated equipment.

3.1. Agreggate

The examination of the characteristics of coarse aggregate, fine aggregate, and filler used for asphalt concrete mixture (LASTON), the results are as in Table 1 and 2.

Table 1. Specification Test of Agregate

Num	Agregate Test	Specification	Result
1	Impact	≤ 30%	28.4%
2	Crushing	≤ 30%	8.21%
3	Aggregate Adhetion to Asphalt	≥ 95%	97%
4	Abration	max 40%	24.9%
5	Thickness and Elongation	max. 10%	1.9% ; 9.3%

Table 2. Specivic Gravity Test of Aggregate

Num	Agreggate	Specification	Result
1	Specivic Gravity of Coarse Aggregate	Min. 2.5	2.56
2	Specivic Gravity of Fine Aggregate	Min. 2.5	2.5
3	Specivic Gravity of Filler	Min. 2.5	2.5

3.2 Asphalt

The result of examination of asphalt characteristic with Esso Pen 60/70 asphalt material done in Road Laboratory of Civil Engineering Department Faculty of Engineering Tarumanagara University is presented in Table 3.

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Table 3. Specification Test Of Asphalt

Asphlat	Specification	Result
Penetration	60 / 70	69 / 70
Ductility	≥ 100 cm	112 cm
Specific Gravity of Asphalt	≥ 1	1.016213
Soft Point	≥ 48°C	53°C
Flash Point dan Burn Point	≥ 232°C	325°C ; 340°C

3.3 *Plastic LDPE*

Plastic waste seed used is a plastic type LDPE (Low Density Polyethylene) obtained from collectors located in Dadap West Jakarta. From the results of testing the specific gravity obtained by the type of plastic waste seeds by 0.919 gr / cm.

Table 4. Specific Gravity Test Of LDPE Plastic Waste

Plastic	Specification	Result
Specific Gravity	≥ 0.91 gr/cm³	0.919

3.4 *Marshall test result Standard (30 minute)*

It can be seen on Figure 1, that the density value of the asphalt concrete mixture without the addition of plastic is higher than the mixture using plastic additive. The addition of plastics in the asphalt mix substituting fine aggregates of greater gravity than plastics. So that the specific gravity in the asphalt and plastic mixture is smaller than the weight of the asphalt mixture without the plastic mixed.

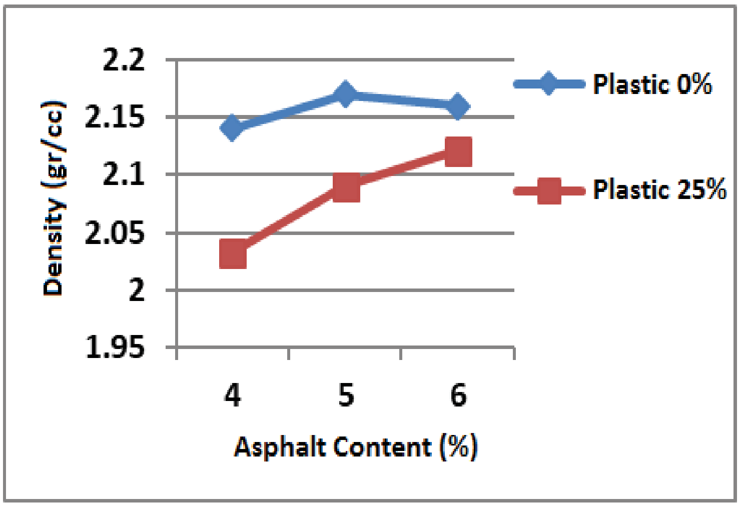

Fig. 1. Chart Comprasion Asphalt with Density

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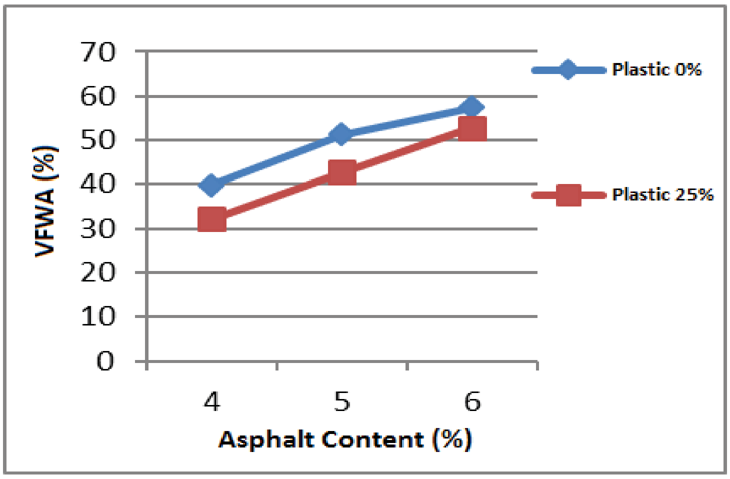

Fig. 2. Chart Comprasion Asphalt with VFWA

As the addition of bitumen content (Figure 2), VFWA value is also increasing. Judging from the addition of plastic content, the value of VFWA decreased, because at the time of mixing the asphalt-covered plastic reduces the amount of asphalt that should fill the cavities in the mix.

From the graph (Figure 3) we can see that the higher the bitumen content the smaller the VITM value. And in the mixture with 25% plastic content showed an increase in VITM value, this is due to the added plastic content blocking the asphalt filling the cavity in the mixture.

It appears that the addition of asphalt content in the three variations will first decrease the value of VMA then if the bitumen content is added then the VMA value will increase. This happens because when the asphalt is added the asphalt can aggregate the aggregate so that the distance between aggregates decreases, but if the asphalt content of asphalt will also cause the distance between aggregates to become enlarged. (Figure 4)

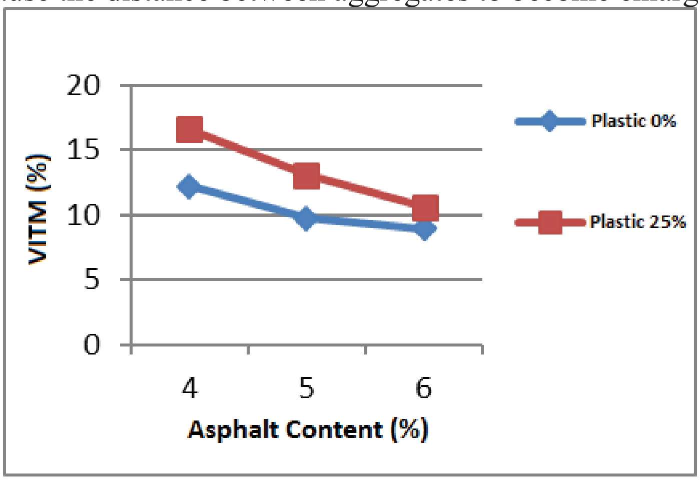

Fig. 3. Chart Comprasion Asphalt with VITM

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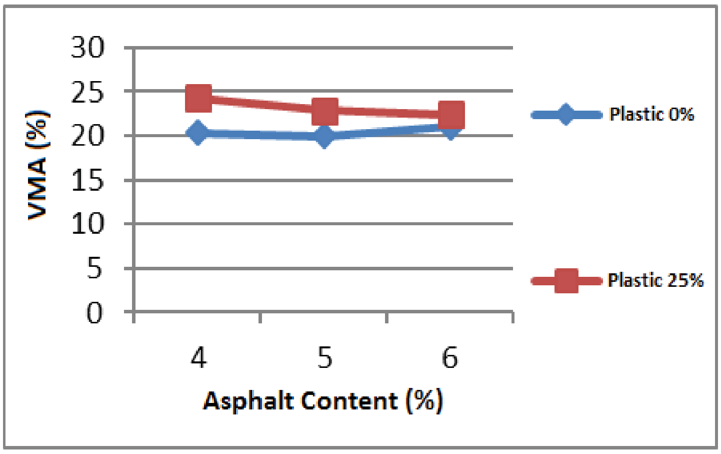

Fig. 4. Chart Comprasion Asphalt with VMA

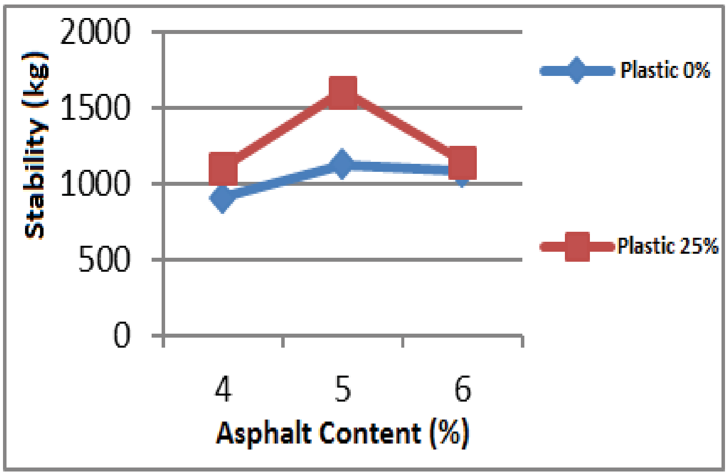

Fig. 5. Chart Comprasion Asphalt Stability

Can be seen (Figure 5) from the graph of test results that with the addition of plastic content, then the value of stability tends to increase. This is due to the added plastic in the form of angled fibers and the asphalt-covered aggregates locking each other up nicely. The aggregate position does not easily move from its place when it is loaded, so its stability increases.

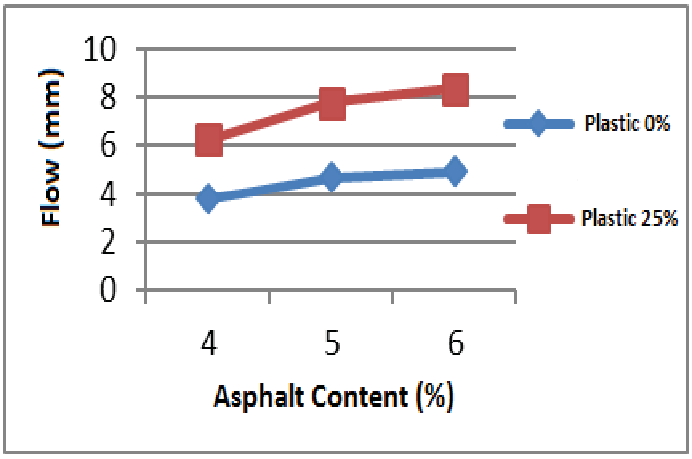

Fig. 6. Chart Comprasion Asphalt Flow

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The value of flow tends to increase at the time of adding more asphalt content and at the time of addition of plastic content. With the added plastic content the flow value will be higher than the mixture that is not added plastic, this is due to the nature of the plastic itself is softer than the rock. (Figure 6)

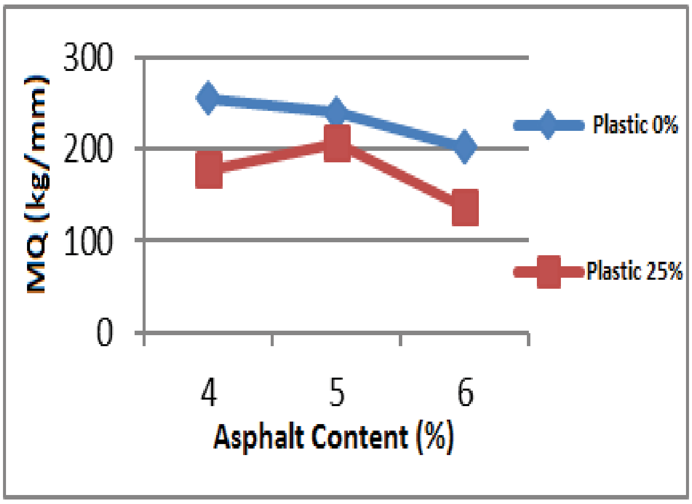

Fig. 7. Chart Comprasion Asphalt MQ

The value of MQ (Marshall Quotient) is the ratio between the stability and flow value, done to find the concrete asphalt mixture. Since the MQ value is the ratio of the stability and flow values, the characteristic of the MQ graph does not have a specific pattern like any other graph. (Figure 7). Comparison of Standard Immersion Results With Immersion 24 Hours

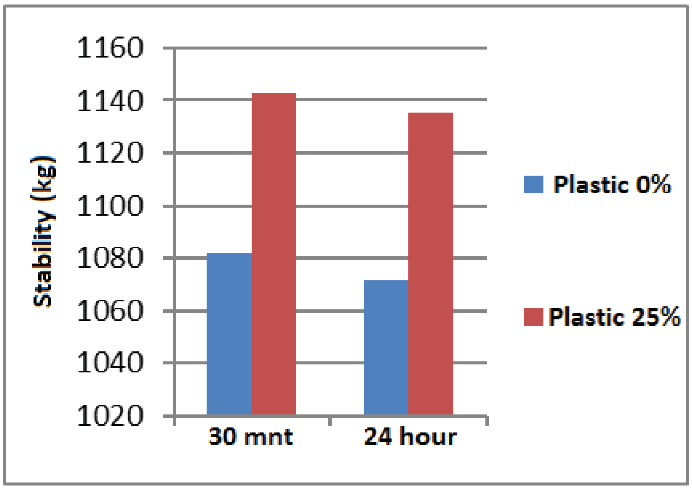

Fig. 8. Graph of Stability Against Submersion 30 Minutes and 24 Hours

It is seen on figure 8, Comparison of Standard Immersion Results (30 minutes) With Immersion 24 Hours (that the longer the immersion time, the stability value will decrease at the plastic content 0% and 25% plastic content). This decrease in stability value occurs because the asphalt is a thermoplastic material hence the nature of the asphalt is greatly influenced by temperature.

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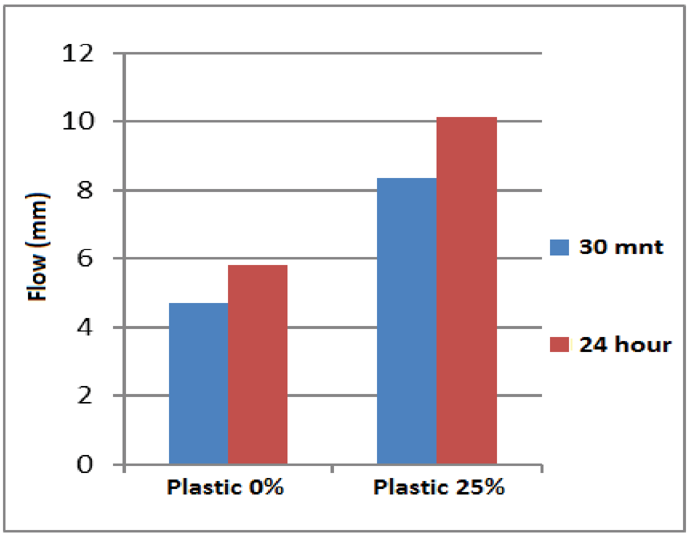

Fig. 9. Graph of flow Against Submersion 30 Minutes and 24 Hours

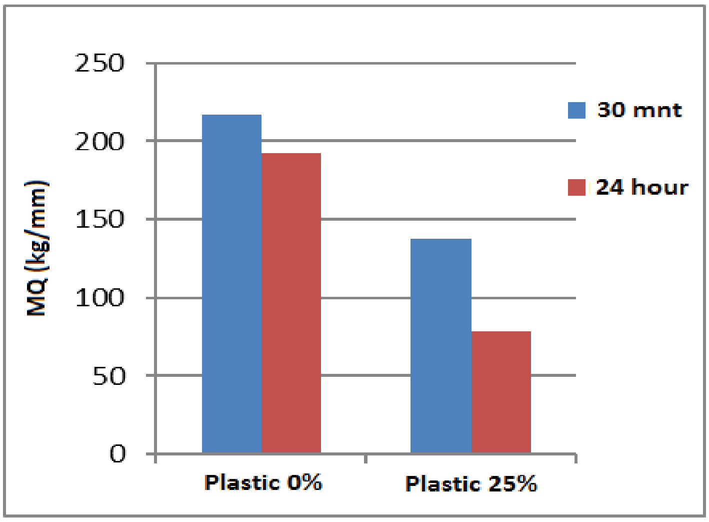

Fig. 10. Graph of MQ Against Submersion 30 Minutes and 24 Hours

The current value will increase as the addition of 25% plastic content. This shows the use of plastics will improve plastic conditions so that pavement will be more vulnerable to loading. (Figure 9)

It appears that the use of plastic will increase the value of Marshall Quotient from the mixture. This is mainly due to the increased stability value significantly compared with the decrease in flow value. The mixture that has a low MQ value, then the hot asphalt mixture will be more flexible, tend to be more plastic and flexible so it is easy to change shape when receiving high traffic load. (Figure 10)

The RMS value on figure 11, the mixture with 25% higher plastic content than the mixture without the plastic,this happens because the mixture with 25% plastic content has less water absorption than the mixture without plastic and the stability becomes higher. Because the RMS value is the ratio between stability and flow value.

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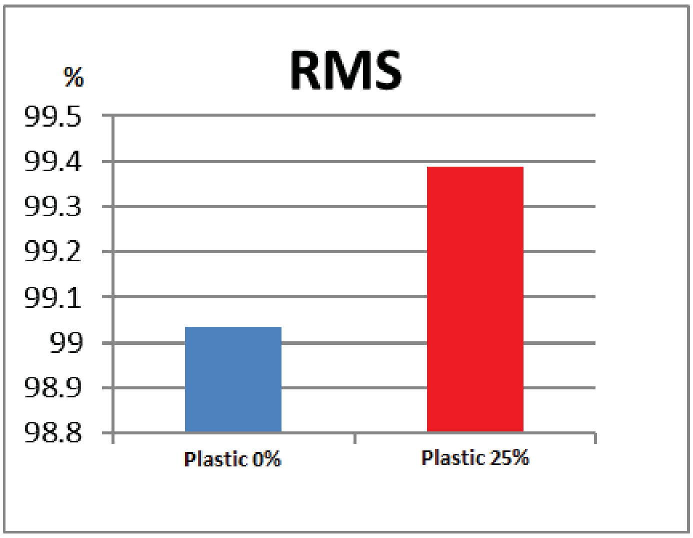

Fig. 11. RMS Chart of Plastic Variation

The RMS value on figure 11, the mixture with 25% higher plastic content than the mixture without the plastic, this happens because the mixture with 25% plastic content has less water absorption than the mixture without plastic and the stability becomes higher. Because the RMS value is the ratio between stability and flow value.

DISCUSSION OF FEASIBILITY OF USE OF PLASTIC IN MIXTURE

The feasibility analysis of the use of waste seed is reviewed from several aspects of consideration, including technical aspects, and environment.

1. Technical Consideration
   Based on the data obtained from the research, the variation of the tested plastic content meets the DGH specification for density, stability, VMA, and flow although there is a decrease in value along with the added bitumen level. So from the technical aspect, the mixture with the plastic waste seeds as a substitute for fine aggregate is feasible to be used as an alternative.
2. Environment Consideration
   With the use of plastic waste seeds in large volumes for a pavement construction, a significant plastic waste treatment solution is obtained. A simple calculation of the quantity of waste plastics that can be used in pavement is as follows:
   The content of plastics that meets the DGH specifications and the RMS results are variations with 25%.
   In an AC-BC mixture with 25% plastic waste content (LDPE) variation, the weight of the plastic is 1.48% of the total weight of the mixture.So every 1 m3 of AC-BC mixture that has a specific gravity of 2.34 gr/cm3 or 2,340 kg/m3 will use LDPE plastic waste seed as much as 1.48% x2340kg = 34.63kg/m3.So for AC-BC mixture with 75cm pavement thickness and road width [2 (2x3.5)] m with a length of 1km road can utilize LDPE plastic waste of 36,315 tons

4. CONCLUSION

Based on the research that has been done by using Low Density Polyethylene (LDPE) plastic waste as a substitute for the coarse aggregate of Asphalt Concrete - Binder Course (AC-BC) mixture, the following conclusions are obtained:

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1. The marshall stability value tends to increase with the addition of 25% plastic content, the highest stability value of 1604.26 kg at standard immersion (30 min) and 1135.47kg at 24 hours immersion.
2. Retained Marshall Stability (RMS) value increased at 25% plastic content, highest RMS value of 99.387%.
3. Variations with 25% plastic content on the mixture increase the value of VITM, VMA, flow, and MQ. While the value of density and VFWA decreased.
4. With the use of plastic waste seeds as substitutes for fine aggregates can reduce the absorption value of the mixture.
5. Replacing 25% fine aggregate retained on sieve no8 in AC-BC mixture withLDPE plastic waste. Can reduceLDPE plastic waste by 36,315 tons along 1 km road.
6. Every 1 m3 of AC-BC mixture that has a specific gravity of 2.34 gr/cm3 or 2,340 kg/m3 will use LDPE plastic waste seed as much as 1.48% x2340kg = 34.63kg/m3.So for AC-BC mixture with 75cm pavement thickness and road width [2 (2x3.5)] m with a length of 1km road can utilize LDPE plastic waste of 36,315 tons

SUGGESTION

1. At the time of mixing the asphalt and plastic need to pay attention to the temperature and duration of the mixer.
2. It needs addition of other plastic content, to see the difference of marshall value that is stability and flow.
3. It is necessary to pay attention to the duration of the compaction temperature not below 140 ° C.Perlu dilakukan penelitian lebih Continued on the same or different mixture types using different plastic sizes and higher plastic content of the study.

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

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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.

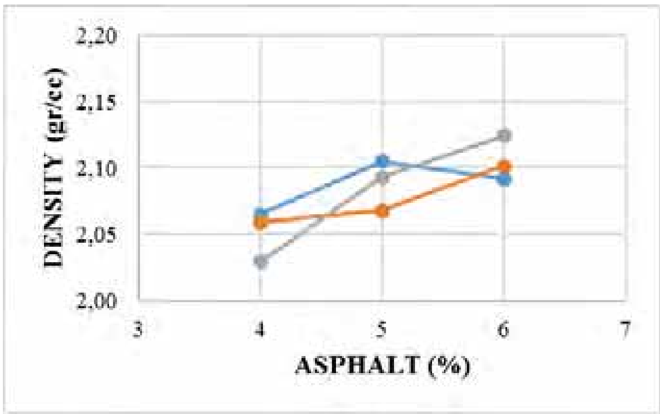

Fig.1.Density - Asphalt Relation, Plastic Content 25% and mixing temperature 160 °C, 170 °C, and 180 °C

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.

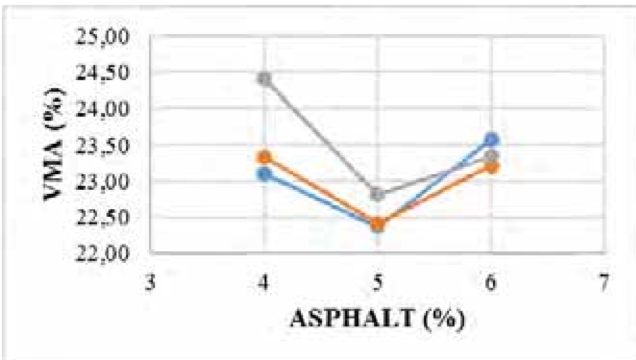

Fig.2. VMA - Asphalt Relation , Plastic Content 25% , and mixing temperature 160 ° C, 170 ° C, and 180 ° C

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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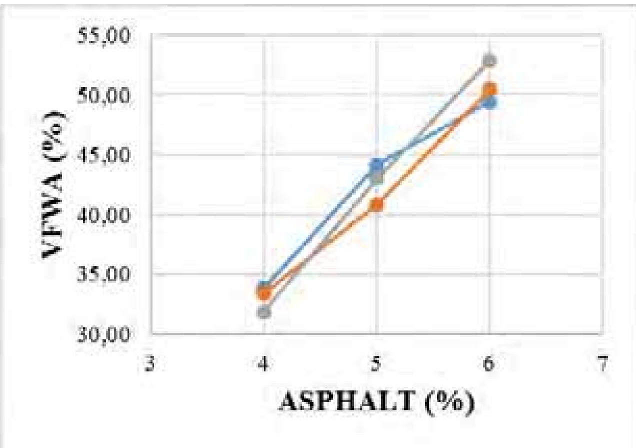

Fig.3. VFWA -Asphalt Relation , Plastic Content25%. and mixing temperature 160 °C, 170 °C, and 180 °C

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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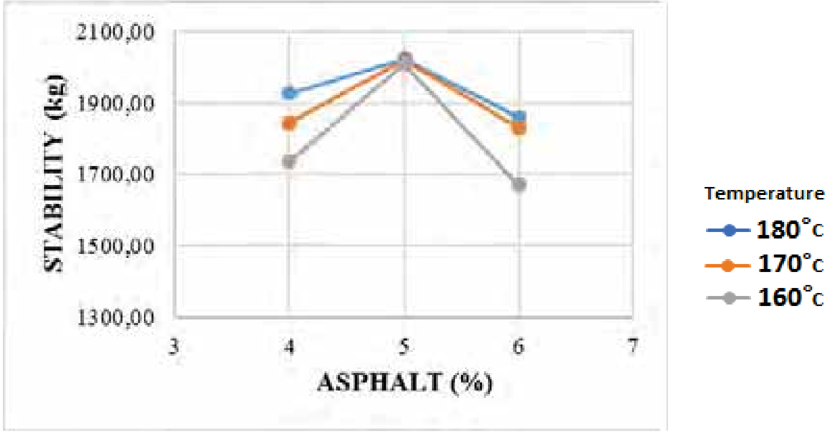

Fig.4. Stability Relation with Asphalt 25% Plastic Content mixing temperature 160 °C, 170 °C, and 180 °C

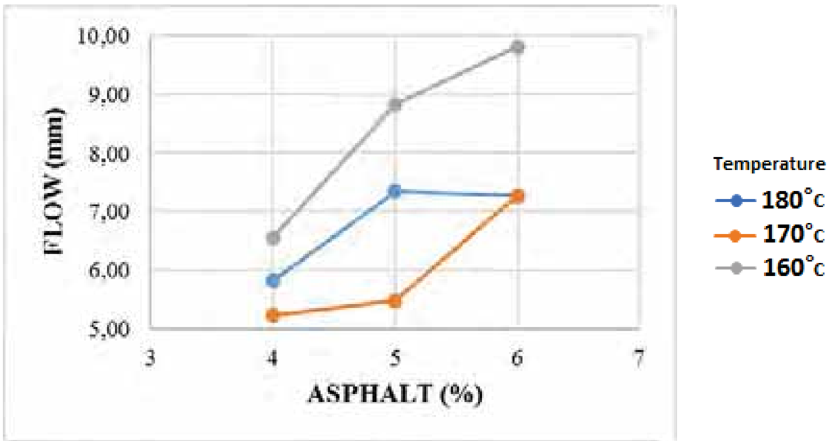

Fig.5. Flow Relation with Asphalt 25% Plastic Content mixing temperature 160 °C, 170 °C, and 180 °C

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.

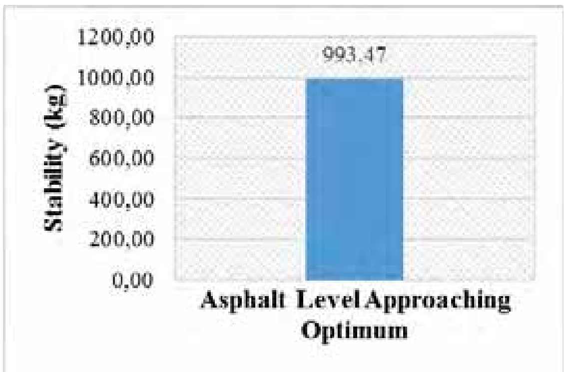

Fig.6.Stability-Asphalt Approaching Optimum Plastic Content 0% Temperature Mix 160 °C

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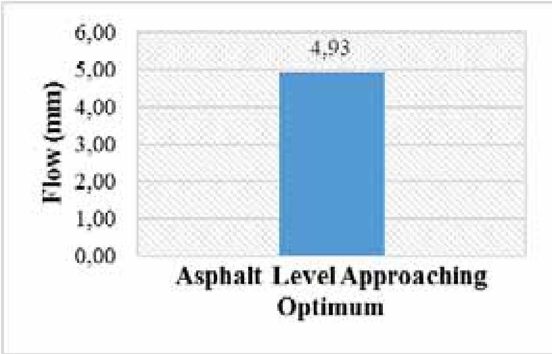

Fig.7. Flow-Asphalt Approaching Optimum Plastic Content 0% Temperature Mix 160 °C

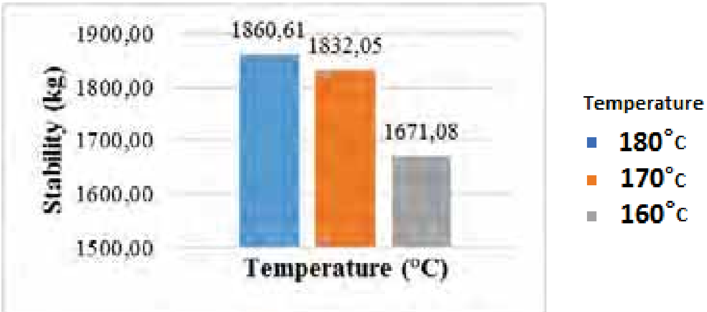

Fig.8. Asphalt Stability Near Optimum 25% Plastic Content Temperature mixing 160 °C, 170 °C, and 180 °C

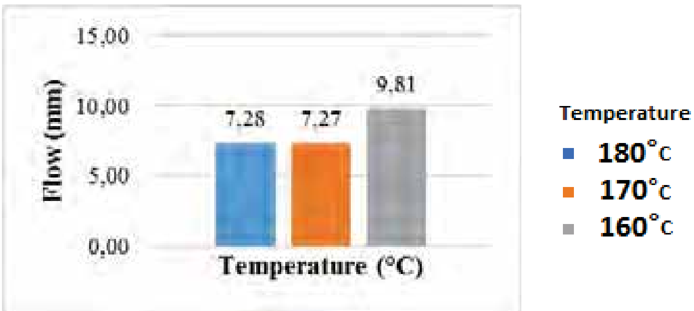

Fig.9. Flow Asphalt Level Approaching Optimum 25% Plastic Content Temperature mixing 160 °C, 170 °C, and 180 °C

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.

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ASPHALT CONCRETE CHARACTERISTICS USING AGGREGATE COATED WITH PLASTIC WASTE LOW DENSITY POLYETHYLENE (LDPE)

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Abstract

Road is the most important infrastructures to facilitate the mobility of person and services in order to improve the economic growth, but most of the roads are damaged by effects of weather that is the rain water intrusion into the pavement layer that accelerates the erosion process. The asphalt erosion process on the adhesion often causing road damage. It needs a material coating so the erosion can be minimize. The Materials used to coat the aggregate surface is LDPE plastic waste. The volume of LDPE plastic waste used as much as 5% of the aggregate retained in sieve no.8, made in the form of a plastic waste pieces. The specimens are cylinders with a diameter of 4 inch and a thickness of 2.7 inch. Marshall testing with the addition of LDPE wasted plastic can increase the stability by 63.75% compared to conventional asphalt concrete mixture.

Keywords: *asphalt, LDPE plastic waste, marshall, stability*

1. INTRODUCTION

Road is the most important land transportation infrastructure which is one of elements in the effort to facilitate the mobility of goods and services in order to improve the national economy. To achieve this, the provision of transportation infrastructure can't be separated from the provide of material of the road construction. Natural aggregates that are often used for pavement construction material are non-renewable materials and in the long run the availability will be used up.

Sukirman (2003) [1], asphalt is a material that at room temperature come in the form of solid, dense, and thermoplastic. The asphalt will melt if heated to a certain temperature, and freeze again if the temperature drops. With aggregates, asphalt is a pavement-mixing material. The weather effect, is intrusion of rain water into the layers construction pavement will result in the acceleration of road damage and aggregate weathering. Therefore need for a material that can help coating agregrat material other than asphalt in the manufacture of road pavement construction materials. The alternative material is Low Density Polyethylene (LDPE) plastic waste can be taken from waste plastic food bags.

Vasudevan (2013)[2],the use of 10% plastic waste in pavement mixture, can reduce 3% void from conventional mixture.

This study is expected to provide data on pavement material in term of the characteristics of the concrete asphalt mixture, using an LDPE plastic waste as coating. The study is also expected to provide an alternative use of LDPE plastic waste by estimating the amount of waste that can be used, thus being the answer to minimize pollution and degradation of environmental due to LDPE plastic waste.

The purpose and objective of this research is to know the effect of the addition of LDPE plastic waste to the increase of asphalt mixture characteristics and to determine the

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optimum bitumen content of the mixture and the LDPE plastic waste to obtain better mixture characteristics of asphalt concrete.

Better planning is the first step in the successful construction of pavement to obtain service age according to plan. To obtain a longer usage life then roads can be designed with the addition of certain substitute materials

The use of LDPE plastic waste as an additive material to the concrete asphalt mixture is expected to improve the stability of the mixture and give a better effect on the properties of the mixture.

The problems exist in this study are the comparison between Marshall characteristic test of conventional asphalt concrete mixture and asphalt concrete mixture with LDPE plastic waste.

The problem in this study is limited only to the characteristics of asphalt concrete mixtures using LDPE plastic waste as a aggregate coating. This research conducted in the laboratory with marshall test and the collection data, using related regulation and journals as a reference to be poured in the basic theory.

2. RESEARCH METHODS

The plastic waste used in this study serves as an additional material to aggregate coating material as a part of the asphalt concrete mixture. Tests conducted in this study according guidelines from DGH 2010 Division 6 revision 3.[3]

Preparation of materials includes activities procurement of materials to be used in research. The materials used in this research included coarse aggregate, fine aggregate, asphalt and LDPE plastic waste.

Aggregates are such as: broken stone, gravel, sand, and filler. Aggregates are crushed stone used together with a bonding medium an asphalt or mortar form.The asphalt concrete layer is a layer of highway construction, which is composed by of a mixture aggregate asphalt and continous graded , mixed, spread and compacted in a hot state at a certain temperature. The mechanical properties of LDPE plastic types are strong, slightly translucent, flexible and some what fatty surfaces. At temperatures below than 60 ° Celsius is very resistant to chemical compounds, water vapor protection is quite good, but not good for other gases such as oxygen.[4]

The materials used in this research consist of coarse aggregate, fine aggregate, asphalt and waste of LDPE plastic which is tested in accordance with the test method used.

The aggregate is weighed according to the gradation plan of each fraction and sieve.The asphalt level approaches the optimum used is 6% of the total weight of aggregate (1100 grams) or as much as 66 grams. Plastic waste content of LDPE is planned at 5%.en the aggregate is heated to 165 ° C, then the weighed plastic is mixed into the pan containing the aggregate being heated and stirred until well mixed, after which is mixed with hot asphalt and then stirred again until evenly distributed. Then the mixture is put into the mold to be pounded as much as 2 × 75 times. The test specimen is made of two (2) pieces for each bitumen content.

Testing the specimen using a marshall test tool. A marshall tool is a press device equipped with a proving ring used to measure the stability and flow meter values used to measure flow. Stages of research follow the steps as follows Flow chart in Figure 1.

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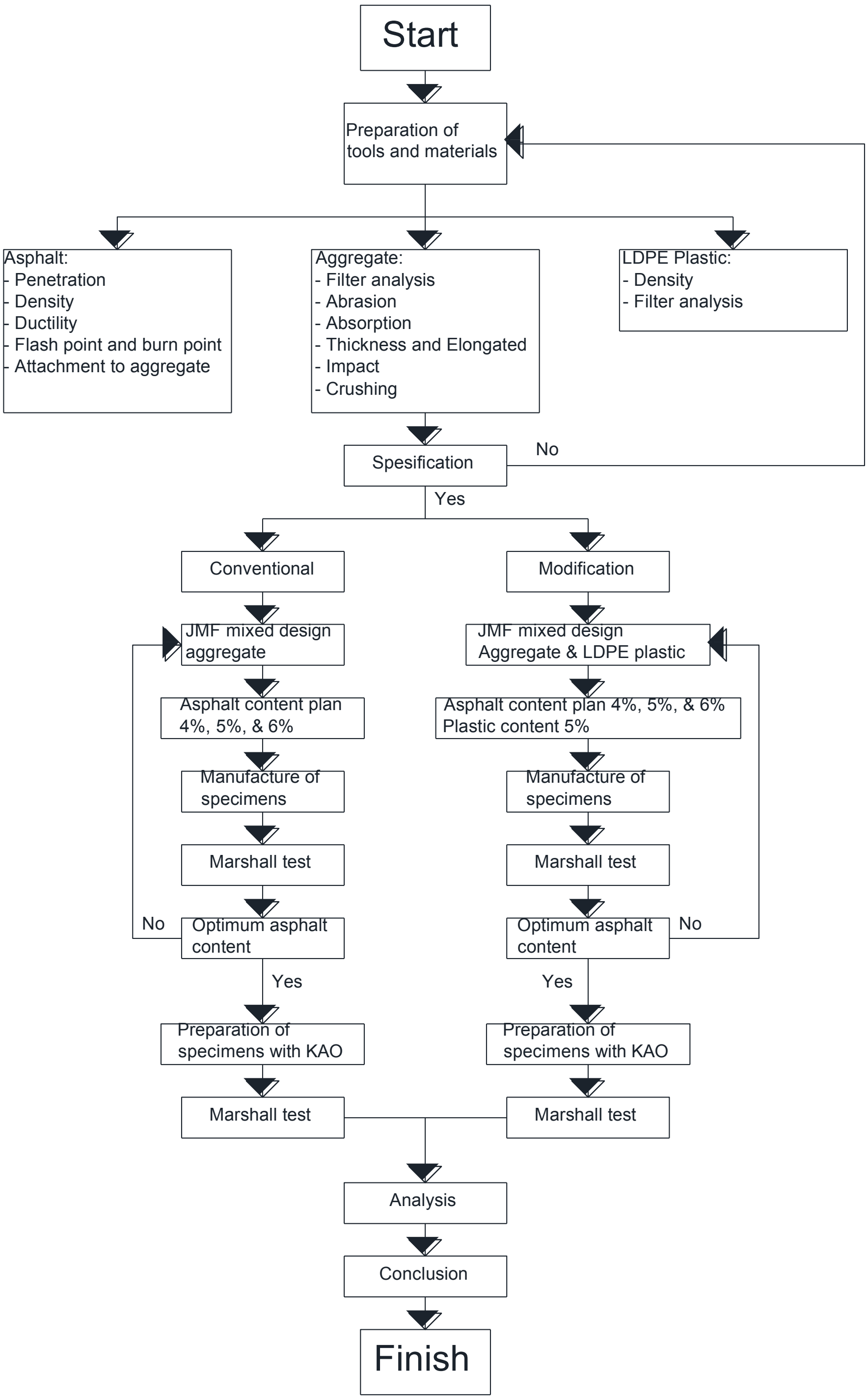

Figure 1. Research's Flowchart

3. ANALYSIS AND DISCUSSION

The first step in this research, we examined the material that will be used to examine the physical characteristics of materials: aggregate, asphalt, and waste of LDPE plastic. It is necessary to know whether the type of aggregate, asphalt, and waste of LDPE plastics used qualified to meet specifications or not. This study was conducted in

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accordance with existing testing guidelines and also supported with was calibrated equipment.

3.1. Aggregate

From the examination of the characteristics of coarse aggregate, fine aggregate, and filler used for asphalt concrete mixture (LASTON), the results are as in Table 1.

Table 1 Results of the Aggregate Characteristic Examination

Aggregate	Specification	Results
BJ. Aggregate Coarse	Min. 2.5	2.56
BJ. Fine Aggregates	Min. 2.5	2.5
BJ. Filler	Min. 2.5	2.5

Table 1 Results of the Aggregate Characteristic Examination (ext)

Aggregate	Specification	Results
Impact	≤ 30%	28.4%
Crushing	≤ 30%	8.21%
Adhesion to Asphalt	≥ 95%	97%
Abrasion	max 40%	24.9%
Kepipihan dan Kelonjongan	max. 10%	1.9% ; 9.3%

3.2. Asphalt

The result of examination of the asphalt characteristic with Esso Pen 60/70 asphalt material done in Road Laboratory of Civil Engineering Department Faculty of Engineering Tarumanagara University is presented in Table 2.

Table 2 Results of Asphalt Characteristic Inspection

Asphalt	Specification	Results
Penetration	60 / 70	69 / 70
Ductility	≥ 100 cm	112 cm
BJ. Asphalt	≥ 1	1.016213
The soft spot	≥ 48°C	53°C
Flash Point and Burn Point	≥ 232°C	325°C; 340°C

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3.3. *Waste Plastic*

Waste plastic used is a plastic type LDPE (Low Density Polyethylene) obtained from the collectors located in Dadap. From the results of the specific gravity test, we obtain the weight of LDPE plastic waste amounted to 0.919 gr / cm³, the result as in table 3.

Table 3 Results of Examination of LDPE plastic waste

Plastic	Specification	Results
Specific gravity	≥ 0.91 gr/cm³	0.919

3.4. *Standard Immersion Marshall Test Results (30 minutes)*

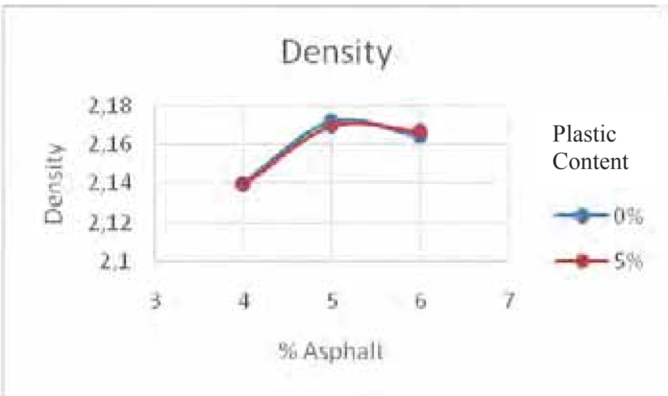

Fig. 1. Comparison Chart Between Asphalt Levels with Density

It can be seen in Figure 1 that the density value of the concrete asphalt mixture without the addition of LDPE plastic waste is higher than the mixture using LDPE plastic waste additive. This is due to the LDPE plastic waste involved covered with asphalt that reduces the level of asphalt that should fill the cavities in the mix.

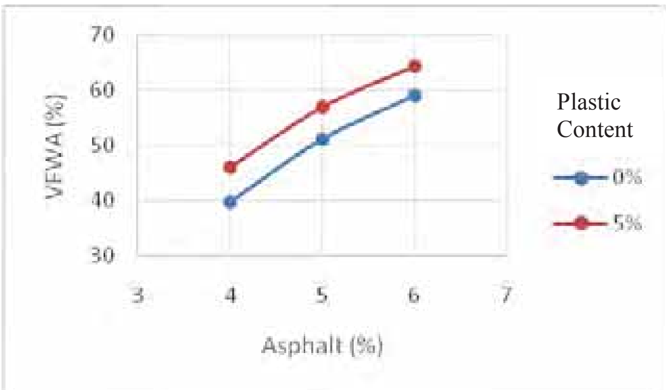

Fig. 2. Comparison Chart Between Asphalt Levels with VFWA

Can be seen in figure 2 as the addition of bitumen content, VFWA value also increased. Judging from the addition of LDPE plastic waste content, VFWA value is increasing, this is caused when the mixing of LDPE plastic waste which is also covered with asphalt reduces the amount of asphalt that should fill the void in the mixture.

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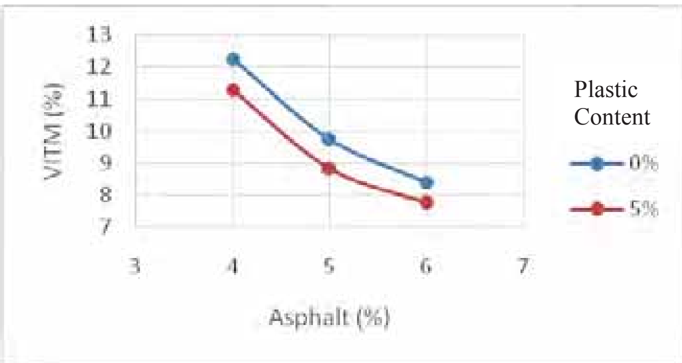

Fig. 3. Comparison Chart Between Asphalt Levels with VIM.

From Figure 3 comparison graph between asphalt content with VITM we can see that the higher bitumen content, the smaller the VITM value. And in mixtures with 5% LDPE plastic content the VITM value decreases, this is due to the added LDPE plastic waste content inhibiting the asphalt void in the mixture.

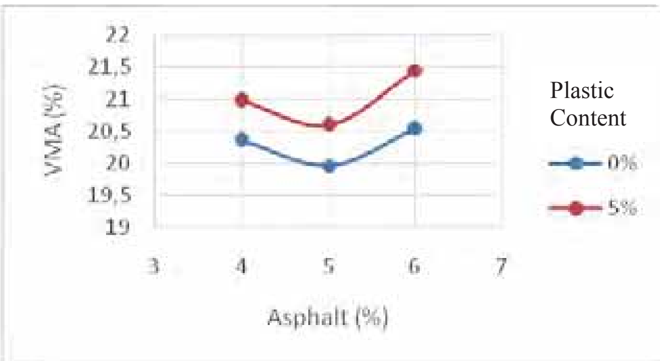

Fig. 4. Comparison Chart Between Asphalt Levels with VMA.

In Figure 4, it appears that the addition of asphalt content in the three variations will first decrease the value of VMA then if the bitumen content is added then the VMA value will increase. This happens when the asphalt is added the aggregate so that the void among aggregates decreases, but if the asphalt content is reduce will also cause the aggregate spacing to become larger.

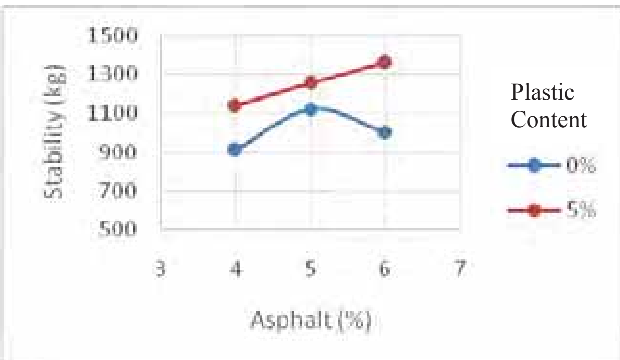

Fig. 5. Graph of Comparison Between Asphalt and Stability.

It can be seen from figure 5, The graph of the test result that with the addition of the LDPE plastic waste content, the stability value tends to increase. This is due to the added LDPE plastic waste in the form of fibers and the asphalt , will covered angled aggregates

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locking each other up . The aggregate position does not easily move from its place when it is loaded, so its stability increases.

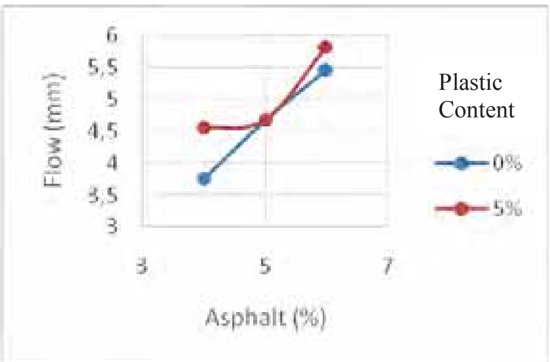

Fig. 6. Comparison Chart Between Asphalt Levels with Flow.

From Figure 6 graph the comparison of asphalt content with flow. It can be seen flow value tends to increase at the time of adding more asphalt content and at the addition of LDPE plastic waste. The addition of LDPE plastic waste content, flow value will be higher than if the mixture is not added by LDPE plastic waste, this is because the nature of the plastic itself is softer than aggregate

3.5. Comparison of Standard Immersion Results With Immersion 24 Hours

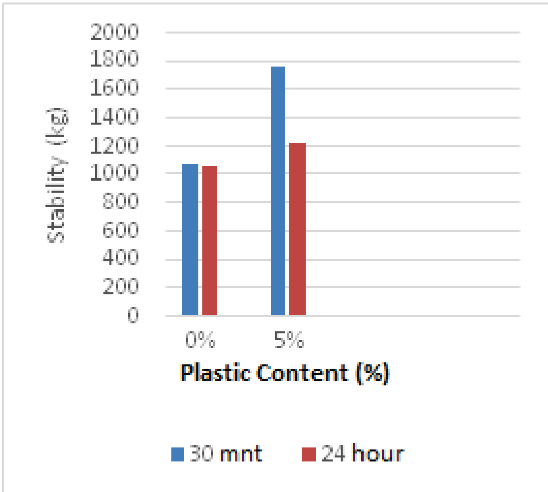

Fig. 7. Graph of Stability Against Soaking 30 Minutes and 24 Hours.

Seen on the picture 7 graph of stability to soaking 30 minutes and 24 hours. The longer the immersion time, stability value will be decrease at the level of plastic 0% as well as the content of 5% LDPE plastic waste. This decrease in stability value occurs because the asphalt is a thermoplastic material hence the nature of the asphalt is greatly influenced by temperature.

In figure 8 the flow graph of 30 minutes and 24 hours immersion shows that. The flow value will tend to increase at the time of addition of 5% LDPE plastic waste content. This indicates that the use of LDPE plastic waste will improve the plastic condition of the mixture so that pavement will be more vulnerable to loading.

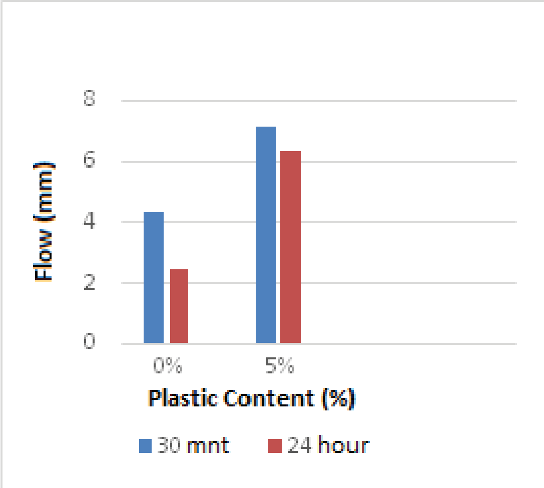

Fig. 8. Flow Chart Against Soaking 30 Minutes and 24 Hours

3.6. Discussion on the Use of LDPE Plastic Waste In Mixture

Environmental Consideration with use of the LDPE plastic waste in large volumes for a pavement construction, a significant LDPE plastic waste treatment solution is obtained. In AC-BC mixture with 5% plastic content variation, the weight of LDPE plastic waste is 5% of total weight of gradation no8. Thus every 1 m3 of AC-BC mixture having a specific gravity of 2.34 gr / cm3 or 2,340 kg will be use LDPE plastic waste as much as 5% x 2340 kg = 117 kg. So for AC-BC mixture with 75cm pavement thickness and road width [2 (2x3.5)] m with 1 km road length can utilize LDPE plastic waste of 122,85 tons..

4. CONCLUSION

Based on the research that has been done by using Low Density Polyethylene (LDPE) plastic waste as a substitute for the coarse aggregate of Asphalt Concrete - Binder Course (AC-BC) mixture, the following conclusions are obtained:

1. LDPE plastic waste can be used as an additional material for gradation aggregate pass sieve no. 4 and retained in sieve no. 8 because the volumetric and Marshall values still meet the required specifications on all variations in the plastic content under test.
2. Stability value tends to increase when the asphalt concrete mixture is covered by the LDPE plastic waste with the result of the stability value increased 63.75% in the manufacture of the specimen with the asphalt content approaching optimum in 30 minutes immersion
3. AC-BC mixture with LDPE plastic waste is feasible to be applied in terms of several aspects,such as engineering, economics, and environment. Technically the use of plastic waste match the specification requirements, economically reducing government costs in plastic waste disposal, and in the environmental aspect can be a handling solution for degradable plastic waste.
4. Flow value increases when plastic content increases. Flow value increased as much 65.35% on the manufacture of specimens with asphalt content approaching optimum in 30 minutes immersion.
5. The air void in the asphalt concrete mixture decreased by 1.08% at the time of adding the plastic content..

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6. By adding LDPE plastic waste as much 5% of the total weight of sieve gradation no 8 in AC-BC with LDPE plastic waste. Can reduce LDPE plastic waste of 122.85 tons along 1 km road.

SUGGESTION

1. Further research is required to determine the other properties of the AC-BC mixture using plastic waste as an addictive to the mixture.
2. Need to do further research by using other types of plastics as an alternative. This will maximize the plastic waste treatment solution.
3. Further research is required on the same or different mixture types using different plastic sizes with higher plastic content from this study, considering the plastic content used in this study still meets the specification requirements.

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