

4_PLASTIC WASTE

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Influence of LDPE Plastic Waste on Asphalt Mixture Soaked in Sea Water

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Abstract. Coastal road pavement ability needs to be improved in order to maintain a good asphalt performance. Samples are made to find a perfect formula for a good performance LDPE, LDPE were added into the mixture with proportion as follows 1%, 2%, 3%, 4%, and 5%. LDPE were chosen because the numbers out on consumption of instant food and beverages as well as cleaning agent for daily use. This research is aiming to investigate the influences of adding LDPE materials in of adding LDPE material in the asphalt mixture to Marshall Parameter values. This will help to reduce the waste and create good asphalt mixture. Researchers has made sixty samples soaked in the seawater for 6, 12, 24, and 48 hours, then do the Marshall Test. The results of this research are the asphalt mixture with LDPE waste has an increase in 1-2% content and has a peak in 3% content, for 4-5% content has a decrease for some Marshall Parameter. In substitution level of LDPE test, it has maximum content at 3% in every soaked process. Thus, adding LDPE waste give a good value to the Marshall Parameters at 3% content, especially for asphalt mixture, which is resistant to the seawater.

1. Introduction

Coastal road pavement is expected to have a high performance in order to keep the traffic safe comfortable and run well. The analysis and design of the asphalt mixture needs to control the quality and pavement materials so that it will match with the performance specification on the location. Flexible coastal pavement mixture is also needed due to the local high tide condition, which can decrease the asphalt mixture performance. The existence of LDPE mixture in the road pavement will help keeping the road. The aim of this research is knowing the influences of adding LDPE plastic waste on asphalt mixture soaked in sea water. The scopes of this research are for asphalt concrete and using LDPE plastic waste.

2. Literature Review

2.1. Adding Plastic Waste LDPE

The effect of adding plastic waste from Low Density Polyethylene (LDPE) material has been mentioned in previous research. This research conducted previously was to find out whether the influence of adding such materials into asphalt mixtures would raise the characteristic performance on the asphalt itself [1].



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Thus, the researcher claimed that after adding asphalt concrete-wearing course (AC-WC), with asphalt penetration on 60/70 as to find out the optimum asphalt level for AC-WC by using LDPE plastic waste type, the durability of the mixtures was raised. Though so, previous researcher had not mentioned experimental samples on soaking the mixtures into saltwater. Therefore, this research is aimed at knowing the durability of mixtures under sea water level as to condition it in Indonesia whereby most of the pavements are closely washed by the high local tide.

2.2. Water Influence

The influence of water toward asphalt was not essential to be discussed because basically asphalt's surface will not mix with water if the blanket is still functioning well. Asphalt's surface was damaged because of the oxidation process (O_2 which binds the H_2 compound and change asphalt's compound into H_2O). Another factor that to damage the asphalt compound is the overweight penetration toward asphalt's surface which gives tremendous chance to oxidation process in the asphalt's pavements. According to George Stefen Muaya, Oscar.H.Kaseke and Mecky.R.E.Manopo [2] "water in aggregates doesn't influence physical condition of aggregates but influence the adhesiveness between asphalt and aggregates" as the previous quotation explains why the researchers consider that the present of water does not influence the physical condition of compounds mixtures but it highly influences attachment within asphalt and the mixtures. This factor is due to the affinity within the water to the mixtures is higher within the asphalt and the mixtures itself. Over all, the problem in concrete asphalt is the existence of water that makes the mixtures loose adhesion and cohesion at the same time in the compounds. This is the reason that weakened the strength of concrete asphalt.

2.3. The Influence of Salt Water Soaking

The influence of soaking salt water into concrete asphalt's layer performance or hot rolled sheet-wearing course (HRS-WC) based on Marshall test and modified durability test [3] has shown that the flexible concrete asphalt road which is soaked by local high sea tide flood got broken in the process. To this phenomenon, it is important to conduct a research about the effect of local high sea tide flood towards the performance of hot asphalt's mixtures-the newest specification on concrete asphalt compound performance based on soaking duration has caused the stability index score decrease in the standard condition and density resistance. This result shows that the duration of HRS-WC level is also getting lower. Thus, this indicated that the longer HRS-WC soaked in the local high sea tide flood will raise the level of flood acid which will lessen the density and performance of the asphalt's compounds sin maintaining adhesion and cohesion of the mixtures.

3. Materials and Methods

Before the test, first step was literature study. The next step before designed asphalt mixture was material testing included aggregates testing and asphalt testing. This testing aims to know the quality of the material that will be used. Based on the test results, the material that would be used has fulfilled the standard. The material testing was using Indonesian standard, such as asphalt penetration testing referred to SNI-06-2456-1991, aggregates gradation testing referred to SNI-03-4142-1996, and the specification referred to Bina Marga (Directorate General of Indonesian Highway) Specification 2018. After the material testing was mix design of optimum asphalt content (OAC) with proportion as follows 1%, 2%, 3%, 4%, 5% of LDPE and created the samples. Then, the samples were soaked in sea water for 6, 12, 24, and 48 hours. After the samples were soaked, then did the Marshall test and got the data analysis based on Marshall parameters. To know the characteristic from an asphalt mixture, it must be done a test using the Marshall machine. Based on the Marshall test, the asphalt mixture can be divided into many parameter, as stability, flow, Void in Mix, Void in Mineral Aggregates, Void Filled with Asphalt,

and Marshall Quotient. Stability is a measure of the ability of a sample for resisting the deformation that is caused by the load. Void Filled with Asphalt is percentage value of void between the aggregates, which is filled by the asphalt but not included the asphalt that absorbed by the aggregates. Void in Mineral Aggregates is percentage value of void between the aggregates, included the air void and asphalt effective volume. Void In Mix designed means that air void value consists of air void between the aggregates, which is covered by the asphalt. Marshall Quotient is comparison between stability and flow. The higher the Marshall Quotient value, the sample will be stiffer and considerate to damage. After Marshall test, the last step was stability and flow test.

4. Results and Analysis

The results from this research were the stability value, flow value, and Marshall Quotient with LDPE content. These are the results from the research :

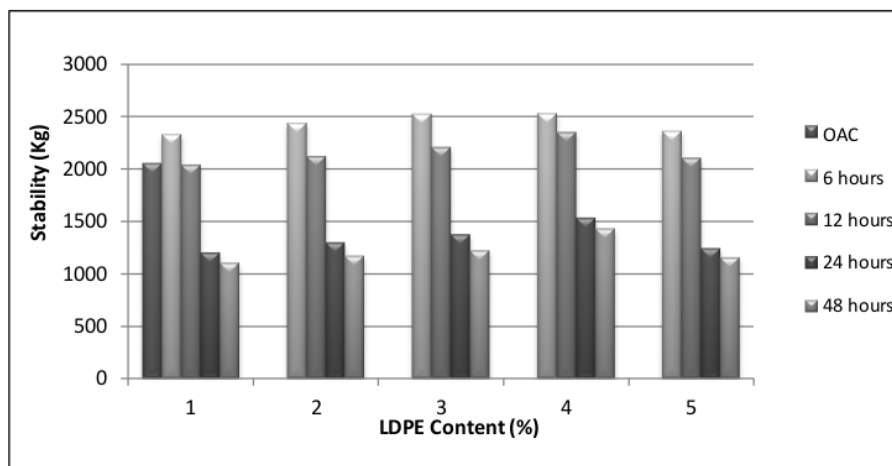


Figure 1. Asphalt Mixture Comparison Diagram Based on The Stability Value

Figure 1, showed stability percentage values for every asphalt mixture after use LDPE waste are various. For the addition 1-5% LDPE content at the 6 and 12 hours soaking have good stability values and for the addition 1-5% LDPE content at the 24 and 48 hours soaking have decrease values because of the soaking time, but this thing can't influence the stability values from Bina Marga specification. On 24 and 48 hours soaked still good for the stability values. The stability values of 1% LDPE on 6 hours soaked is taller than usual asphalt material, because LDPE waste's viscosity is bigger. Values from 5 LDPE content and soaked for 6 hours has average increase 18.6%, 12 hours 5.4%, 24 hours has stability values decreasing until 35% from the normal asphalt content and 48 hours soaked has values 40.7%, but for 24 and 48 hours soaked values still fit with Bina Marga standard. This stability values will reduce the material so it impacts on the road pavement construction costs. Where the higher the stability values, the thickness of asphalt course will be thinner, so the material will be reduced and decreased the construction costs.

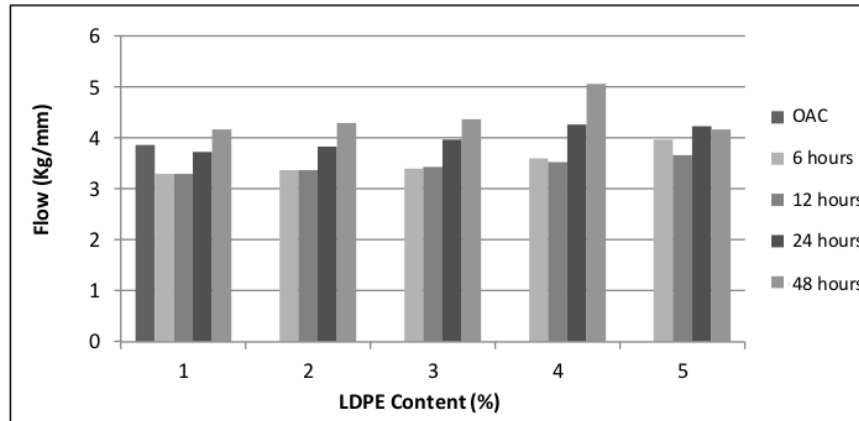


Figure 2. Asphalt Mixture Comparison Diagram Based on The Flow Values

Figure 2, showed the flow percentage values for every asphalt mixture after use concrete waste is increase as the LDPE content increase and soaked time. This thing is influenced by the concrete waste mixture factor or temperature. In addition, 1-3% content has good flow values and in 4-5% content has flow values increment. This thing is caused by adding LDPE waste and soaked process time which causing asphalt mixture flow. Flow values for this asphalt mixture increase a little than the normal asphalt mixture, this thing is protected will increase a flexibility in asphalt mixture, so it is not susceptible to crack.

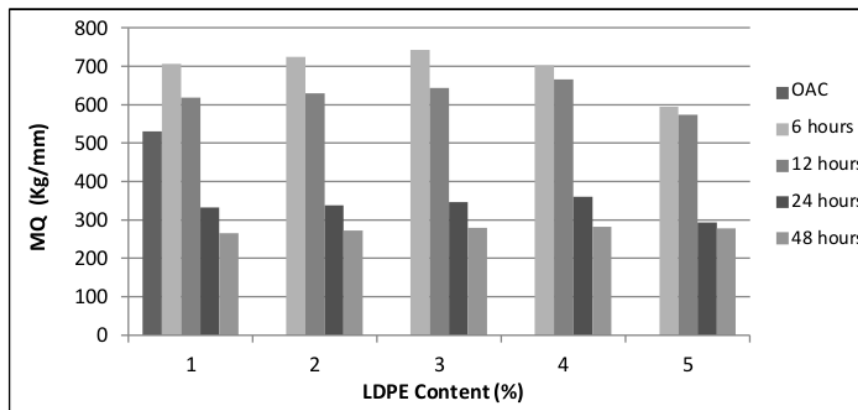


Figure 3. Asphalt Mixture Comparison Diagram Based on Marshall Quotient Values

Figure 3, showed MQ percentage values for every asphalt mixture decrease after adding LDPE waste. Generally, MQ values often reviewed at the time of implementation at field. This MQ values is comparison between stability values and flow values. If one of the parameter values don't fulfilled the requirements, the MQ values will not fulfilled too. Comparison between normal asphalt mixture with the addition of 1-5% LDPE decrease from 4-5% content for each soaked, start from 6, 12, 24 and 48 hours, but MQ values still fit with the Bina Marga specifications. The lower MQ values, the stiffer pavement course and considerate to damage. Otherwise MQ values, pavement course will be more flexible.

5. Conclusions

Based on the experiment that has been conducted, the following conclusions are obtained:

- a. LDPE waste content substitution to the asphalt material can improve stability values maximally from normal asphalt mixture, which the LDPE is 1-5%. Have stability values increase average at 3-4% content in all soaked. The stability values will influence the thickness of the asphalt course for road pavement, the higher stability values, the thickness of the road pavement course will decrease, so it can cut down the material and costs.
- b. LDPE waste content substitution at 1-5% content on 6, 12, 24, and 48 hours soaked have void in mix values are increasing, have maximum values at 3% to asphalt material. This thing will make asphalt mixture will make asphalt mixture and concrete waste is not waterproof.
- c. LDPE waste content substitution to asphalt material can decrease void in mineral aggregates values. In addition, of the 1-5%, LDPE content in asphalt mixture at soaked for 6, 12, 24, and 48 hours have good values at 3% content. Void in mineral aggregates still fulfill Bina Marga specifications based on the minimum limit, 15%.
- d. LDPE waste content substitution to asphalt material can decrease void filled with asphalt from normal asphalt mixture where 1-5% LDPE waste have maximum average values at 3% content. Void filled with asphalt values still fulfill the specifications based on minimum limit.
- e. LDPE waste content substitution to asphalt material can increase flow values from normal asphalt mixture where 1-5% LDPE waste have maximum at 3% content, it is just be influenced by soaked time, so the flow values increase. Flow values at asphalt mixture with 3% LDPE waste still fulfill Bina Marga specifications. Asphalt mixture with LDPE waste can improve the flexibility
- f. LDPE waste content substitution to asphalt material can increase MQ values from normal asphalt mixture where the maximum MQ values still at the 3% addition of LDPE, LDPE content addition fulfilled Bina Marga specifications.
- g. LDPE waste addition has fulfilled Marshall parameter values, which is required by Bina Marga, but the use of the optimum LDPE waste content is 3-4%. Therefore, the use of LDPE waste able to be apply to AC-WC asphalt-concrete course by using optimum content from each LDPE waste.

6. References

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