



## Asphalt Modification Using Low Linier Density Polyethylene (LLDPE) Plastic And Cigarette Butt Filter Waste

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### ABSTRACT

The development of technology in the transportation sector is increasingly advanced, many renewable innovations are continuously being developed. Various studies have been carried out to find the best solution for finding new innovations. The management of LLDPE plastic waste and cigarette filters into a modified asphalt mixture is an example of renewable technology. The purpose of this study was to determine the impact of adding LLDPE plastic waste and cigarette filters into the modified asphalt mixture, with a variation of 20% LLDPE and cigarette filters 5%, 10%, 15%. The results showed that with the addition of the mixture to the modified asphalt, there was a decrease in the value of Stability, MQ, VIM, VMA, VFB, and Flow.

### INTRODUCTION

From year to year, the traffic volume has increased significantly, both private and public vehicles [1][2]. This increase requires a quality road construction process. Quality pavement layers will provide comfort and safety in driving. For climatic conditions and road pavement conditions in Indonesia, a hard binder, high softening point, elastic, good adhesion, and durable [3]. The pavement itself consists of aggregate material mixed with a binder, namely

asphalt [4]. The use of additives and additives in the manufacture of asphalt is a solution in efforts to improve the quality or adjust the properties of the asphalt itself. The use of substitute materials or fillers in the asphalt concrete mixture is an alternative that can be done [5]. Waste produced by humans and nature is an alternative material that can be used as a substitute material [6]. The utilization of waste will make the waste have use-value. Examples of waste materials that can be used as additives include materials containing LLDPE plastic elements and cigarette filters [7]. LLDPE is the type of polyethylene that is chosen because it can be found anywhere. with a density of 0.90-0.94 g/cm<sup>3</sup>. The addition of plastic to the bitumen had a significant effect on the value of penetration, softening point and ductility using pure asphalt pen 60/80. Overall, the use of plastic waste as an additive to asphalt shows the effect of increasing the quality of asphalt, which is better than pure asphalt [8]. Meanwhile, cigarette filters are used because they are found scattered on the roadside, so they are considered useless. Because the amount is very large, both of these materials can be used as replacement materials.

Several previous studies that have relevance to the addition of material to asphalt have been carried out by several researchers [4]. Tjitjik Wasiah Suroso (2008) in the journal entitled “Pengaruh Penambahan Plastik Ldpe (Low-Density Poly Ethilen ) Cara Basah Dan Cara Kering Terhadap Kinerja Campuran Beraspal,” states that with the addition of LDPE material, the Stability, Marshall, VFB, and MQ values will be greater than conventional asphalt, and with the presence of LDPE plastic mixture, the asphalt is not mixed evenly. However, this modified asphalt has the advantage of the economic value of asphalt. This study aims to determine the effect of adding LLDPE plastic waste and cigarette filters to the modified asphalt mixture. This study aims to determine the impact of adding LLDPE plastic waste and cigarette filters into the modified asphalt mixture.

## METHODS

The method used is the experimental method, where the results of this study show the results of the cause and effect of one variable to another. The research was carried out by making test objects at the Civil Engineering Laboratory of Kadiri University. In this study, there are 4 main ingredients used as ingredients for the modified asphalt mixture, aggregate, filler, asphalt, and added materials in the form of LLDPE plastic waste and cigarette filters. The specimen is cylindrical, 4 inches (10.16 cm) in diameter, and 3 inches (7.5 cm) high with. A sample mixture of 20% LLDPE and filter waste 5%, 10%, 15%.

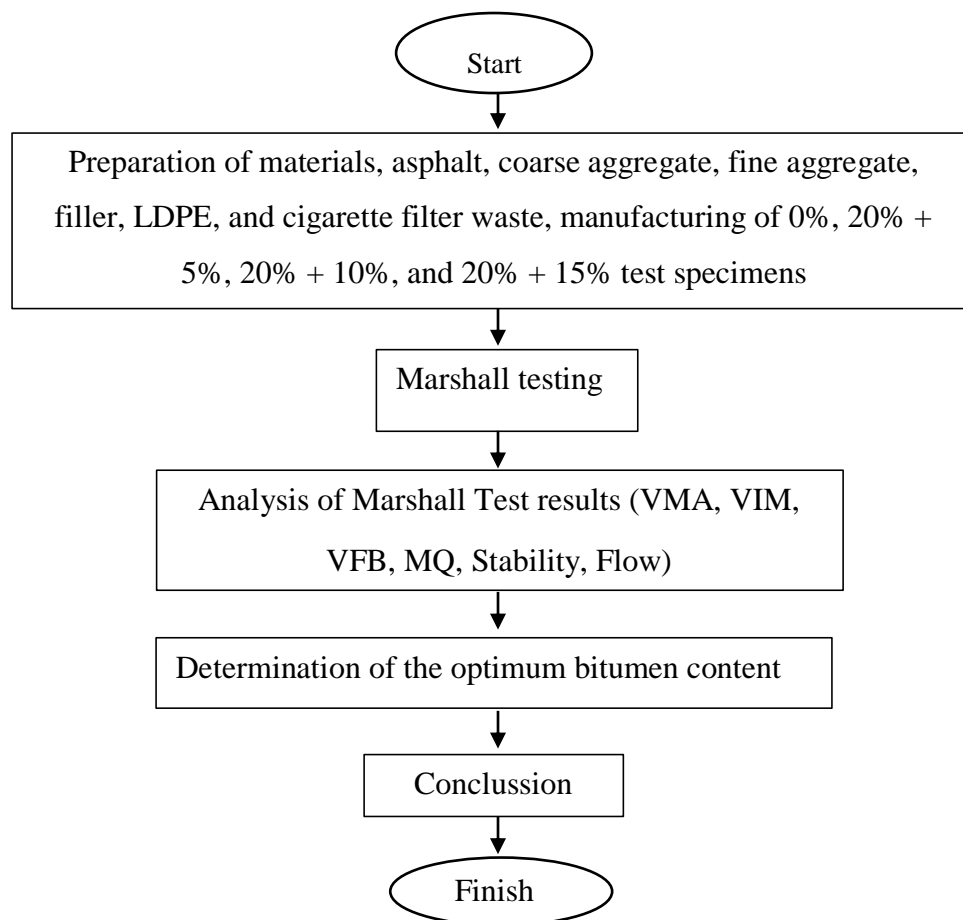
**Table 1.** Sample Design

Sample	Bitumen Content (PB)	LLDPE	Filter	Test day	Number of Sample
0%	5%	0%	0%	1 day	3
5%	5%	20%	5%	1 day	3
10%	5%	20%	10%	1 day	3
15%	5%	20%	15%	1 day	3
Amount =					12

Source: Research data

**Research Flow**

The following are the stages of the research carried out from beginning to end which are described as such:



**Figure 1.** Research Flow

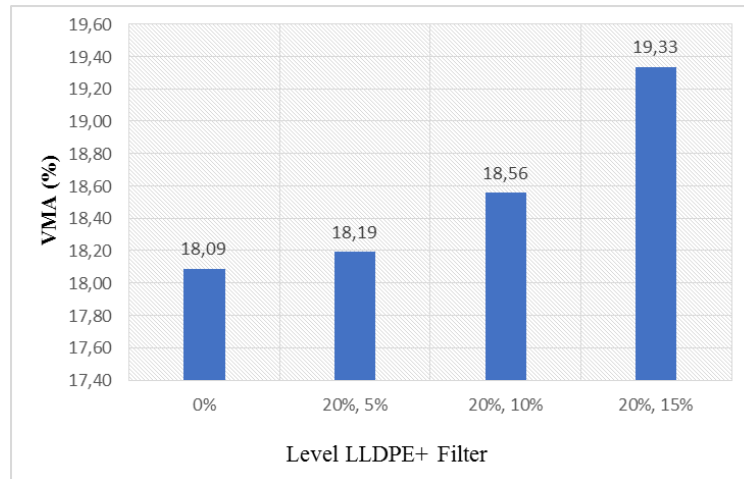
The research started from the preparation stage of materials and tools, followed by the manufacture of a sample of 12 samples with a variation of 0% mixture (normal asphalt), 20% LLDPE mixture, and 5%, 10%, 15% cigarette filters. After the sample is made then tested by Marshall testing. From the Mashall test, the analysis was carried out to determine the optimum bitumen content.

## RESULTS AND DISCUSSION

The test results using the Marshall method are described as follows:

### Void Mineral Aggregate (VMA)

According to the 2010 general specification, revision 3 that the VMA value in asphalt mixtures is a minimum of 15%.



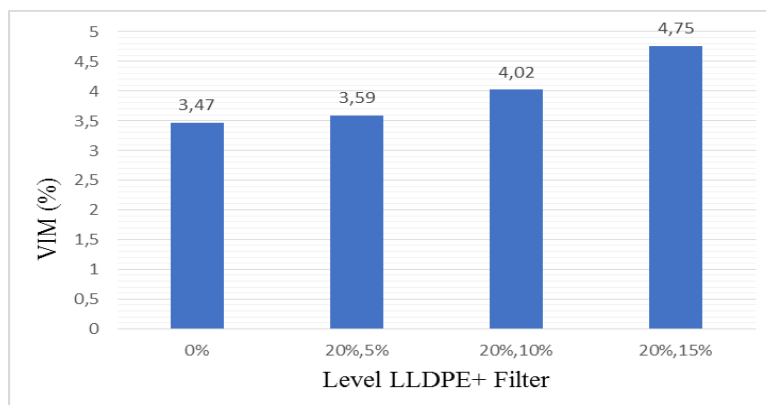
**Figure 2.** Graph of the relationship between levels of the mixture and the VMA value

*Source: Research Data*

Based on Figure 2 above, shows the relationship between the levels of the mixture with the VMA value on the test object. The results obtained showed an average yield of 18.09% for 0% mixture, 18.19% for 20% LLDPE + 5% mixture, 18.56% for 20% LLDPE + 10% mixture, 19.33% for mixture. 20% LLDPE + 15% mixture. Based on the test results of the four test objects, it can be concluded that all test objects meet the specifications.

### Void In Mix (VIM)

The VIM values that have been determined in the 2010 general specifications, revision 3 are 3% to 5%.



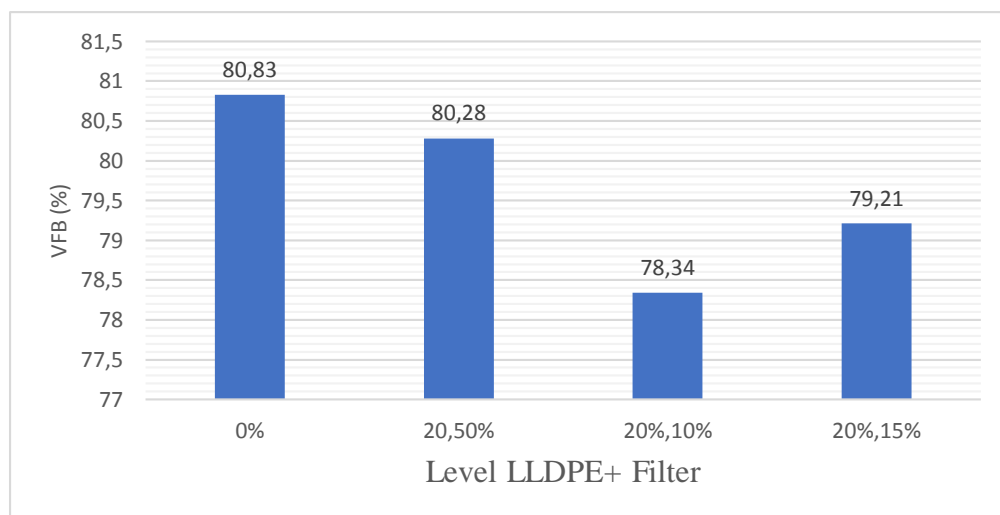
**Figure 3.** Graph of the relationship between levels of the mixture and the VIM value

*Source: Research Data*

From the test results presented in Figure 5 above, the VIM (Void in mix) value is obtained with an average result of 3.47% at 0% mixture, 3.59% in a mixture of 20% LLDPE + 5% mixture, 4.02% for a mixture of 20% LLDPE + 10%, 4.75% for a mixture of 20% LLDPE + 15%. Based on these results it can be concluded that those that do not meet the specifications are the 20% LLDPE + 5% mixed specimen, while the other three specimens meet the General 2010 Division 6 specifications that have been set by the Directorate General of Highways of the Ministry of Public Works of the Republic of Indonesia.

#### **Voids Filled with Bitumen (VFB)**

Voids Filled with Bitumen (VFB) is given a minimum value of 65%. VFB is the portion of the cavity between the mineral aggregate (VMA) that is filled with effective asphalt, expressed in percent



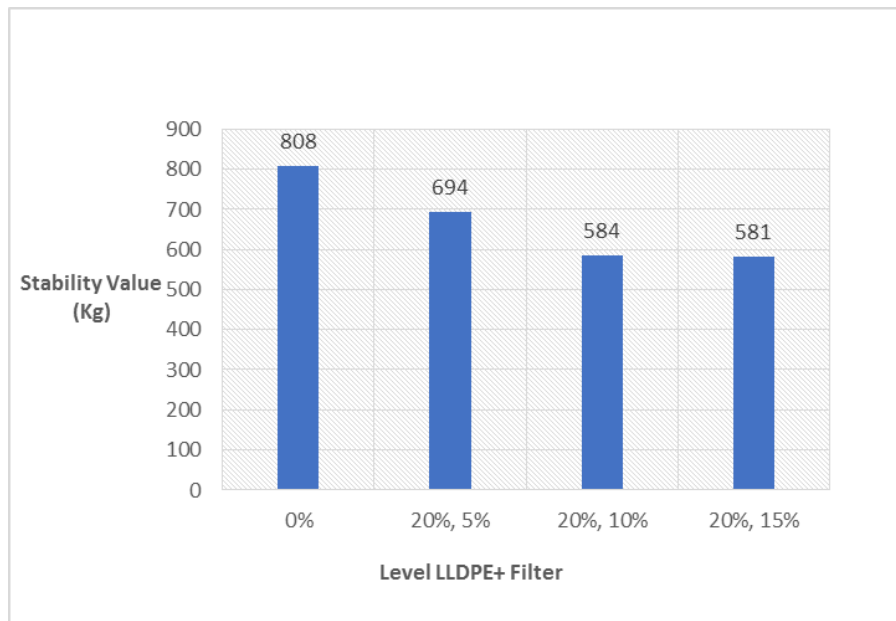
**Figure 4.** Graph of the relationship between levels of the mixture and the VFB value

*Source: Research Data*

From the test results presented in Figure 6 above, the VFB (Void Filled Bitumen) value is obtained with an average result of 80.83% in 0% mixture, 80.28% in a mixture of 20% LLDPE + 5% mixture, 78.34% for a mixture of 20% LLDPE + 10%, 79.21% for a mixture of 20% LLDPE + 15%.

#### **Stability**

General specifications 2010 Revision 3 that have been stipulated by the Directorate General of Highways, Ministry of Public Works of the Republic of Indonesia, are  $\geq 800$ kg. Stability increases with increasing bitumen content to a certain extent then decreases



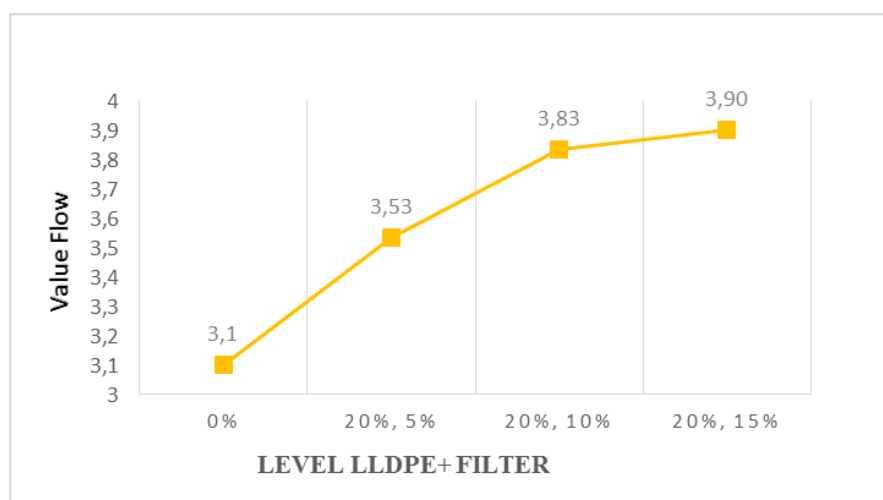
**Figure 5.** The relationship between levels of the mixture with the value of stability

*Source: Research Data\*

Based on **Figure 5** above, it shows that the highest stability value is in the sample of 0% specimen without LLDPE mixture and filter with a stability of 808 Kg, for the lowest stability is in the test object on the test object 20% LLDPE + 15% Filter with a stability value of 581 Kg. Then for the 20% LLDPE + 5% filter specimen, the stability value of 694 kg is obtained, and the 20% LLDPE + 10% filter for the test object is 584 kg.

**Flow**

Flow is a number that shows the amount of vertical drop in the test object. Specifications of the Directorate General of Highways of the Ministry of Public Works of the Republic of Indonesia, with a minimum number of 2 mm to 4 mm.



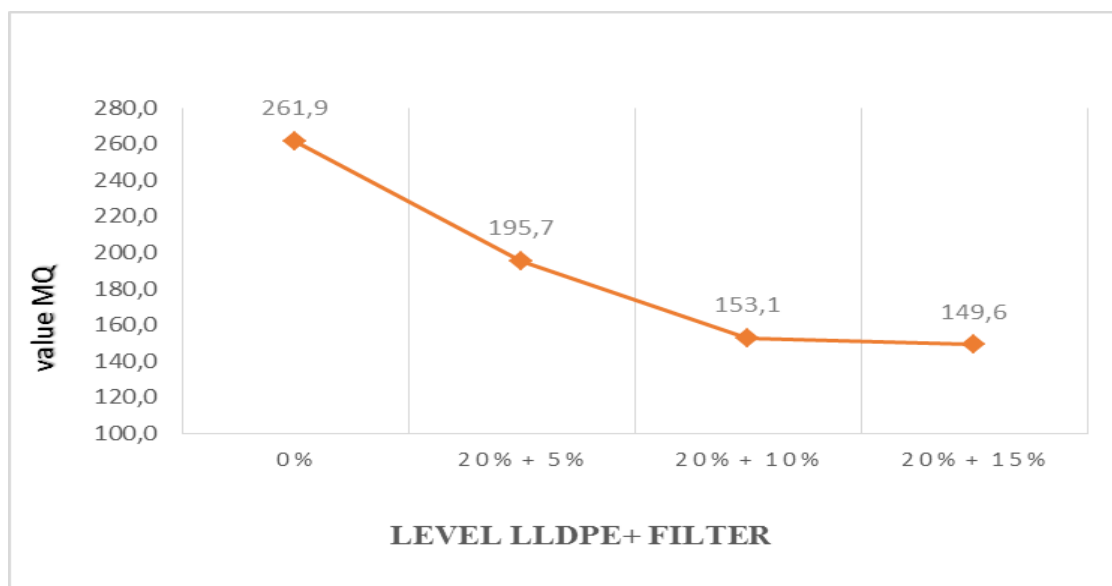
**Figure 6.** The relationship between levels of the mixture with Melt value

*Source: Research Data*

Figure 6 explains that from this research, the average flow value of the test object is 0% without mixture, a mixture of 20% + 5% filter, 20% + 10%, and 20% + 15%, which is 3.1 mm, 3, 5 mm, 3.8 mm, 3.9 mm, with the highest value of 3.9 mm for the 20% LLDPE + 15% filter specimen, and the lowest value for the 0% mixed test specimen with a value of 3.1 mm. Thus it can be concluded that the increasing number of percentages in the LLDPE mixture and cigarette filters can cause the plastic melt value (Flow) to increase in value.

### Marshall Quotient (MQ)

MQ is a number that states the level of flexibility (flexibility) of a mixture. MQ is the quotient of the stability value to flow. Specifications that have been determined by Bina marga with a minimum value of 250 kg / mm.



**Figure 7.** The relationship between levels of the mixture with value of MQ (marshall quotient)

*Source: Research Data*

The results above show that the highest value of MQ (marshall quotient) is in the sample of 0% specimen without LLDPE and filter mixtures with an MQ value of 261.9 Kg / mm, for the lowest stability, namely the test object on the test object 20% LLDPE + 15% Filter with MQ value of 49.6 Kg / mm. Then for the 20% LLDPE + 5% filter specimen, the MQ value was 195.7 Kg / mm, and for the 20% LLDPE + 10% filter test object 153.1 Kg / mm. The low value of Marshall quotient in a mixture of 20% LLDPE + 15% Filter, is due to the small stability and large flow and thicker enveloped aggregate and will ultimately reduce the binding power between the aggregates in the mixture when loaded. The reduced bond between the aggregates will reduce the stability of the mixture which leads to an increased flow value.

## KAO

The amount of optimum asphalt content varies, depending on the properties of the asphalt, aggregate, aggregate grading and the type of mixture itself. The optimum asphalt content is an absolute requirement in every asphalt pavement mixture.

**Table 2.** The Test Value of Optimal Asphalt Levels

No.	Kadar	Parameter Marshall	VIM (%)	VMA (%)	VFB (%)	Stability (kg)	FLOW (mm)	MQ (kg/mm)
	20% LLDPE + Filter	Spesification	3-5,	>15%	>65	>800	2-4,	min 250
1	0%							
2	20% + 5%					694		195.7
3	20% + 10%					584		153.1
4	20% + 15%					581		149.6
TEST OBJECT TEST LLDPE MIXED 20% AND FILTER			=			20 % LLDPE + 5% FILTER		

Source: Research Data

Based on the marshal parameter test of the LLDPE mixture and cigarette filter levels, the results are shown in Table 2. The optimum asphalt content is 20% LLDPE mixture and 5% cigarette filter, due to the value of the Marshall parameter (VIM; VMA; VFB; Flow; Stability; MQ ) almost approaching, referring to the specifications that have been determined by the Directorate General of Highways of the Ministry of Public Works of the Republic of Indonesia which are contained in the 2010 General Specifications, Revision 3, Division 6 concerning Asphalt Pavement and SNI 06-2489-1991

## CONCLUSIONS

Dari penelitian yang telah dilakukan, maka dapat diambil kesimpulan sebagai berikut

1. There is a decrease in the value of stability, the value of MQ, and an increase in the value of flow, VIM, VMA
2. From the 20% LLDPE + cigarette filter mixed asphalt test, the optimal asphalt content (KAO) value is 20% LLDPE + 5% Filter, because the values on the Marshall VMA, VIM, VFB, FLOW parameters have met specifications, while the STABILITY value , MQ almost meets specifications. So it is determined that the optimum asphalt content value is in the asphalt mixture of 20% LLDPE + 5% Cigarette filter.

## Suggestions

It is necessary to use material that has good quality so that this research can be used as a study in planning a pavement. Future studies are expected to be more selective in



choosing the materials used, because material selection is very important in determining the research results.

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