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The Effect of Addition of Used Styrofoam on the Characteristics of Asphalt Physical Properties

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Abstract. Styrofoam had many purposes, especially for the safety of electronic objects, because it is light, durable and strong. The volume of styrofoam is enormous, reaching 30% of total waste in the world. Therefore, it causes problems if disposed of and it will become a very inconvenient waste and it can undermine the environment. This study aims to determine the effect of adding former styrofoam waste to asphalt on the characteristics of the 60/70 pen asphalt. The sample was made by melting the Styrofoam with Xylene then putting it in heated asphalt and then stirring it evenly. Next, Styrofoam enters the material into the sample container and then is refrigerated outside for 1 hour. After that, the sample is immersed in water for 3 hours. The sample meets the asphalt requirements test for each sample including penetration test, softening point, flash point, burning point, density, and ductility. This shows that the higher the concentration, the addition of styrofoam mixed with asphalt resulted in conversion and increased performance of the mixture. While at density, it appears that the addition of Styrofoam results in a lower density value.

Keyword: styrofoam, asphalt, physical properties.

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1 Introduction

Styrofoam has very light, rigid, translucent, and inexpensive properties. This makes styrofoam has the potential to be a mixing material to make modified asphalt. The use of modified asphalt using styrofoam mixture material still has to go through several stages of testing and evaluation [1]. Testing and evaluation aims to determine the strength of modified asphalt when applied as a highway manufacturing material [2]. The use of asphalt pen 60/70 on pavement in the long term is not good enough to withstand heavy loads (overloading), so it is necessary to add additives to make asphalt more durable [3].

Styrofoam is divided into 2 namely Foamed Styrofoam (FS) and Expanded Styrofoam (EPS), also known as Polystyrene foam, which is commonly known as styrofoam [4]. In some countries, styrofoam has been applied as an additional material on asphalt. In Baghdad, Iraq, styrofoam has been used on several roads and can lower cracks and rutting, reduce aging,

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increase skid resistance [5]. Efforts to improve the quality of the hard layer should still take into account the funding conditions. Nowadays it has been widely used a variety of added materials to improve the quality of asphalt mixtures, among others by adding polymers [6]. Styrofoam can reduce vulnerability to temperature fluctuations, reducing maintenance costs as it improves durability and pavement performance. In addition, its use in asphalt mixture can reduce styrofoam waste by 40-88% [7].

Roads as land transportation infrastructure is very important. Road as one form of land transportation system that serves to connect one area with another area [8]. Indonesia's road network has been traversed by traffic with increasing load characteristics, high traffic volume and not comparable to available capacity, as well as increasing double pressure [9-10]. Road is one of the factors that influence the development of development in Indonesia. The quality of the road is comparable to the level of smoothness of road transportation. One of the factors that affect the quality of the highway is the material used in road construction [11].

Materials used in road construction include asphalt. Mixing with other materials makes the use of asphalt reduced. There are several materials that can be used as asphalt mixing material, one of which is styrofoam. Styrofoam has very light, rigid, translucent, and inexpensive properties. This makes styrofoam has the potential to be a mixing material used to make modified asphalt [12]. Styrofoam is used based on considerable use in everyday life but is little utilized. The use of modified asphalt using styrofoam mixture material still has to go through several stages of testing and evaluation. Testing and evaluation aims to find out the strength of asphalt modifications when applied as road construction materials. Assessment of Handling Plastic Deformation and Cracks due to Traffic Load has been researched by the Research and Development Agency of the Department of Public Works [13]. The use of added material type on asphalt material depends on the objectives to be achieved, namely improving asphalt chemistry with additional materials such as arbocell, roadcel-50 [14]. Styrofoam Can also serve as an adhesive if mixed with gasoline.

In this study, tried using Styrofoam material mixed with asphalt material to see changes in the physical properties of asphalt [15]. The results of this study will provide preliminary information about the characteristics of asphalt concrete mixture that can be improved by the addition of Styrofoam into the asphalt concrete mixture [16-17].

2 Methods

This research was conducted in The Construction Materials Laboratory of Bina Marga and Construction Development of North Sumatra Province.

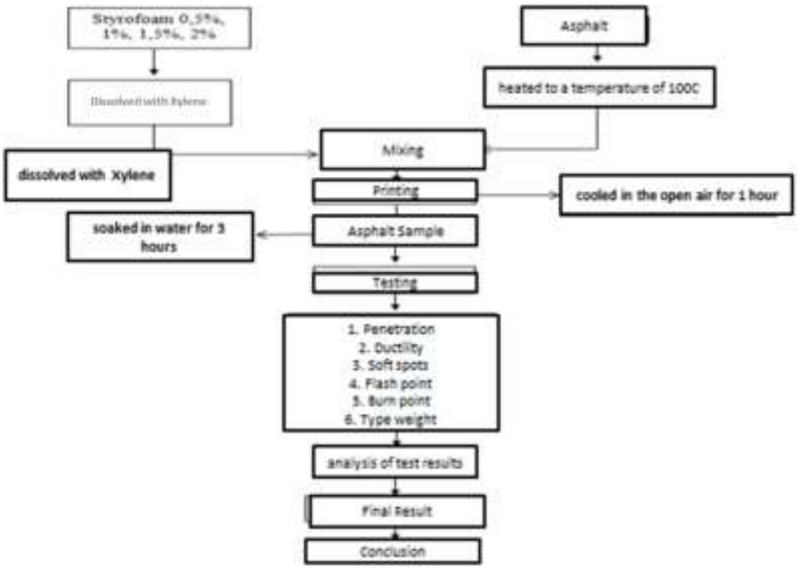

Figure 1. Research Flowchart

3 Result and Discussion

3.1 Penetration Test Results

Table 1. 60/70 Pen asphalt penetration test results with Styrofoam

Sample	Material Composition		Penetration Results (mm)
	Asphalt (g)	Styrofoam (%)	
A1	800	0	60
A2	800	0.5	65
A3	800	1	69
A4	800	1.5	71
A5	800	2	73

Table 1 Shows that the higher the concentration of Styrofoam addition mixed on asphalt resulting in a change in asphalt penetration value.

3.2 Soft Spot Test Results

Table 2. Test result of soft spot asphalt pen 60/70 with Styrofoam

Sample	Material Composition		Time (s)	Soft Spot Test Results (°C)
	Asphalt (g)	Styrofoam (%)		
L1	800	0	10.13	48
L2	800	0.5	12.45	49
L3	800	1	16.50	50
L4	800	1.5	15.26	51
L5	800	2	14.17	53

Table 2 shows that the value of asphalt soft spots is 48°C. The addition of Styrofoam by 0.5% to 2% has an impact on increasing the value of soft spots to 49°C to 53°C.

3.3 Test Results of Flashpoints and Burn Points

Table 3. 60/70 asphalt pen test results with styrofoam

Sample	Material Composition		Results	
	Asphalt (g)	Styrofoam (%)	Flash Points (°C)	Burn Points (°C)
N1	800	0	200	250
N2	800	0.5	255	285
N3	800	1	260	290
N4	800	1.5	266	295
N5	800	2	268	300

Table 3 shows that the point value of Asphalt flame is 200°C. The addition of Styrofoam by 0.5% to 2% has an impact on the increase in the value of the point to 255°C to 266°C. Then at the asphalt burn point value is 250°C. The addition of Styrofoam by 0.5% to 2% has an impact on the increase in the value of the point to 285°C to 300°C.

3.4 Ductility Test Results

Table 4. 60/70 asphalt pen ductility test results with Styrofoam

Sample	Material Composition		Ductility Results (cm)
	Aspal (g)	Styrofoam (%)	
D1	800	0	100
D2	800	0.5	110
D3	800	1	118
D4	800	1.5	126
D5	800	2	130

Table 4 shows that the length of the test trough in this study was 152 cm. The minimum required ductile value is 100 cm. The following results of ductility testing addition of Styrofoam were 110 cm to 130 cm.

3.5 Weight Type Test Results

Table 5. Test result of asphalt pen type weight 60/70 with styrofoam

Sample	Material Composition		Results (g/mm)
	Aspal (g)	Styrofoam (%)	
J1	800	0	1
J2	800	0.5	1.0855
J3	800	1	1.0189
J4	800	1.5	0.9861
J5	800	2	0.9810

Indicates that the Mass Value of asphalt type is the highest density, which is 1 g/ml. It appears that the addition of Styrofoam resulted in a lower density value [2].

4 Conclusion

The addition of styrofoam into the asphalt is likely to increase the penetration value of asphalt which means the asphalt becomes softer. The test results of asphalt physical properties are as follows: penetration value of 60 mm to 73 mm. Soft spots at mixed levels of 48°C to 53°C. The flash point is 200°C to 268°C. The burn points were 250°C to 300°C. As the temperature increases, the faster it rises and burns. Ductility test values were 100 cm to 130 cm. The density test value of 1 g/ml to 0.9810 g/ml decreased against the addition of styrofoam levels. This research is the basis for looking at the ability to mix asphalt with polymer materials where in this study is styrofoam. The results showed that the more styrofoam percentage on asphalt will further improve the performance of the mixture with the use of styrofoam.

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