The Effect of Polypropylene (Pp) Plastıc Waste on Horızontal Deformatıon of Concrete Asphalt

by A. Arwin Amiruddin Teknik Sipil Unhas

The Effect of Polypropylene (Pp) Plastıc Waste on Horızontal Deformatıon of Concrete Asphalt

Sukrislistarto[1], Muhammad Isran Ramli[1], Mubassirang Pasra[1], A. Arwin Amiruddin [1], and Hajriyanti Yatmar[1]

[1]Department of Civil Engineering, Universitas Hasanuddin
sukrislistartopalu2018@gmail.com
isranramli@unhas.ac.id
mubapasra@gmail.com
arwinamiruddin@yahoo.com

Abstract. This study designed a concrete asphalt mixture using petroleum bitumen as the main binding material and modified it with waste plastic polypropylene (PP) instead of using virgin plastic Polypropylene (PP) to produce concrete asphalt that has concrete good resistance to the impact of weather on the environment. The value of Indirect Tensile Stiffness Modulus (ITSM) is one of the main characteristics of asphalt mixture design. The relationship between the content of waste plastic Polypropylene (PP) and the horizontal deformation response of asphalt concrete is used to obtain the elasticity properties of asphalt concrete mixtures made with petroleum bitumen and plastic waste Polypropylene (PP). The horizontal deformation response obtained from the test results shows that modification using Polypropylene (PP) plastic waste in a concrete asphalt mixture using petroleum bitumen as the main binder produces a slightly more rigid mixture without a negative effect on the mixture.

Keywords : PP (Polypropylene), AC-BC, Asphalt oil

1 Introduction

Consider the importance of the road sector as a major aspect of the urban landscape and observe material use. A number of failures were identified on several roads, which require precise measurements to avoid these failures, including the correct level of asphalt concrete mixing control in the standard and the correct use of bitumen from coarse aggregate particle coatings and the successful use of material-based laboratory tests to ensure proper implementation. Fatigue cracking and pitting are the main pressures that reduce the condition of an adequate road system, making it risky and dangerous for road users and affecting the country's economy. What is important in this scenario to reduce the initial damage to asphalt concrete is that making asphalt mixtures with characteristics that are modified using additives such as polymers is the main resolution for building durable asphalt. Using polymers depends on several factors such as cost, ability expected construction, availability and performance. The use of virgin plastic Polypropylene (PP) as an additive will increase the cost of asphalt concrete mixture so this research tries to use plastic waste Polypropylene (PP) derived from disposable plastic waste as a polymer additive.

Polymers are able to improve the properties of asphalt concrete mixes because it gives the possibility to produce a mixture that can withstand cracks and grooves. Virgin polypropylene (PP) has been widely used as a polymer capable of modifying concrete asphalt mixtures [1].

By using Polypropylene (PP) plastic waste it is expected to be able to reduce Polypropylene (PP) plastic waste while reducing the use of virgin Polypropylene (PP) plastic waste in concrete asphalt mixtures. Indirect Tensile Stiffness Modulus (ITSM) value is one of the main characteristics of asphalt mixture design. ITSM value is the property of stiffness or elasticity of asphalt mixture which is measured using tensile strength testing [2, 3]. Also in the test can be shown the horizontal deformation response caused by nuts to produce a horizontal stretch of 5μ. This paper discusses the useful application of Polypropylene (PP) plastic waste as modifiers in concrete asphalt mixes made with petroleum bitumen as the main bitumen binder. The main objective of this paper is to study the effect of adding Polypropylene (PP) plastic waste in relation to the horizontal deformation response of a concrete asphalt mixture. The results of the study are expected to be an important basis for improving the properties of asphalt concrete mixes.

2 Materials and Methods

2.1 Outline of Sustainable Studies for Utilizing Plastics in Asphalt Concrete Production

At a fundamental level, ongoing research is needed on the development of asphalt mixtures containing plastic waste such as Polypropylene (PP) plastic waste and petroleum bitumen that show in the following figure.

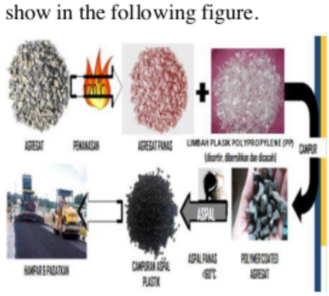

Figure 1. Outline of sustainable studies for utilizing plastic including waste Polypropylene (PP) and petroleum asphalt in the production of concrete asphalt

The Figure 1 shows an outline of ongoing studies for utilizing plastics including Polypropylene (PP) plastic waste in asphalt concrete.

2.2 Mixed Proportion

All aggregates are collected from the Jeneberang river located in South Sulawesi Province, Indonesia. Broken stone is obtained from local crushed stone plants. Table 1 shows the physical properties of coarse aggregates. River sand is used as fine aggregate. Table 2 shows the fine aggregate properties. Table 3 shows the gradation limits recommended by the Indonesian Road Directorate's road specifications, for the AC-BC mixture and the gradations selected in this investigation are in the middle of the boundary. Table 4 shows the nature of petroleum bitumen. Polypropylene (PP) plastic waste is collected from one of the plastic waste processing plants. Used plastic used has been cut into small pieces, in dry and clean conditions

Table 1. Physical properties of coarse aggregates

Property	Test value
Bulk specific gravity (kg/m^3)	2698
S. S. D. specific gravity (kg/m^3)	2703
Apparent specific gravity (kg/m^3)	2712
Water absorption (%)	2.08
Water absorption of filler (%)	2.28

Table 2. Physical properties of fine aggregates

Property	Test value
Bulk specific gravity (kg/m^3)	2684
S. S. D. specific gravity (kg/m^3)	2710
Apparent specific gravity (kg/m^3)	2756
Water absorption (%)	0.962

Table 3. Grading binder type 2

Sieve size (mm)	Gradation limits (%)	Passing (%)	Retained (%)
19	90 - 100	100	0
12.5	75 - 90	95.00	5.00
9.5	66 - 82	81.00	14.00
4.75	46 - 64	53.00	28.00
2.36	30 - 49	33.55	19.45
1.18	18 - 38	22.30	11.25
0.6	12 - 28	16.05	6.25
0.3	7 - 20	12.25	3.80
0.15	5 - 13	9.50	2.75
0.075	4 - 8	7.00	2.50
Pan	-	0	7

Table 4. Properties of petroleum asphalt

Properties	Value	Unit
Penetration at 25°C	69,07	0.1 mm
Softening Point	55,42	°C
Ductility	112	cm
Flash Point	322,67	°C
Density	1,15	
Loss on Heating TFOT	0,030	% wt
Penetration after loss on heating	78,00	0.1 mm

The specification requirements specified for the asphalt concentrate mixture are taken into account to obtain optimal binder content. The mechanism of field compaction can be compared to laboratory simulation with the practice of Marshall compaction that is applied. Laboratory cylinder specimens with a diameter of 100 mm and a height of about 65 mm are compacted using seventy-five Marshall hammer blows per side. Based on Marshall design procedures, the optimal bituminous content is 4.5%. Triple specimens were made for ITSM tests. Mixture without Polypropylene (PP) plastic waste and others with Polypropylene (PP) plastic waste in a 1.0% and 1.5% mixed concentration prepared.

As mentioned earlier, the binder content which corresponds to air void 4% was chosen as OBC. The following steps are taken for the formulation of compacted specimens:

1. The mixture of aggregate and filler is heated to 160 ° C.
2. The binder is heated to 150 ° C.
3. Wasted PP is heated to 150 ° C.
4. The combination of aggregates, fillers, PP waste, and binders are mixed at 150 ° C.
5. The formulated specimen is then compacted at 135 ° C using Marshall equipment.

2.3 Tough Modulus (Indirect Pull Hardness Test) (ITSM)

Figure 2 shows the ITSM test equipment. Ductile modulus assumes that asphalt concrete mixes can be recovered under repetitive loads in an elastic range. The tensile stiffness modulus test (ITSM) is not directly applied to obtain rigid moduli or rigid moduli from asphalt mixed specimens. Load pulses are applied to the vertical diameter of the cylindrical specimen. Horizontal transient horizontal deformation of 0.005% of the diameter of the specimen is obtained by controlling the peak load value. The indirect tensile stiffness modulus (ITSM) test is a non-destructive test and has been identified as a potential means for measuring stiffness properties [4, 5, 6].

Indirect tensile stress test (ITSM) is used to determine the tensile properties of asphalt concrete which can be further related to cracks that occur in asphalt mixtures, especially AC-BC mixtures. Strain control is used to evaluate the stiffness modulus where the test object is given sinusoidal axial loading of the oscillation in a voltage at a constant amplitude of 5 microstrains.

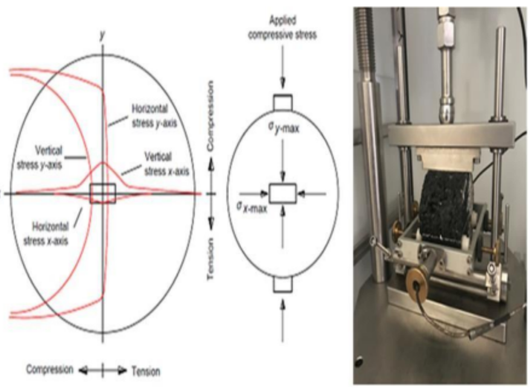

Figure 2. ITSM test equipment

3 Results and Dıscussıon

Table 5 shows the relationship between horizontal deformation responsibilities and variations in Polypropylene (PP) plastic waste mixtures, Polypropylene (PP) plastic waste content and ITSM values. Variations in the mixture of Polypropylene (PP) palastic waste by 0% with an angle of α 34,090 and the use of Polypropylene palastic waste (PP) of 1.0 and 1.5%, respectively, obtained an α angle of 41,250 and 42,270, respectively. Show that Polypropylene (PP) plastic waste can be mixed with petroleum bitumen and has a positive effect on the stiffness of asphalt concrete mixtures. ITSM values obtained from the test results show that the modification using Polypropylene (PP) plastic waste in a concrete asphalt mixture using petroleum bitumen as the main binder produces a slightly more rigid mixture.

Table 5. Relationship of Horizontal Deformation to the amount of waste variation in Polypropylene (PP)

No	PP Plastic Waste Mixture Variations	Angle (^{0})
1	0 %	$34,09^0$
2	1,0 %	$41,25^0$
3	1,5 %	$42,27^0$

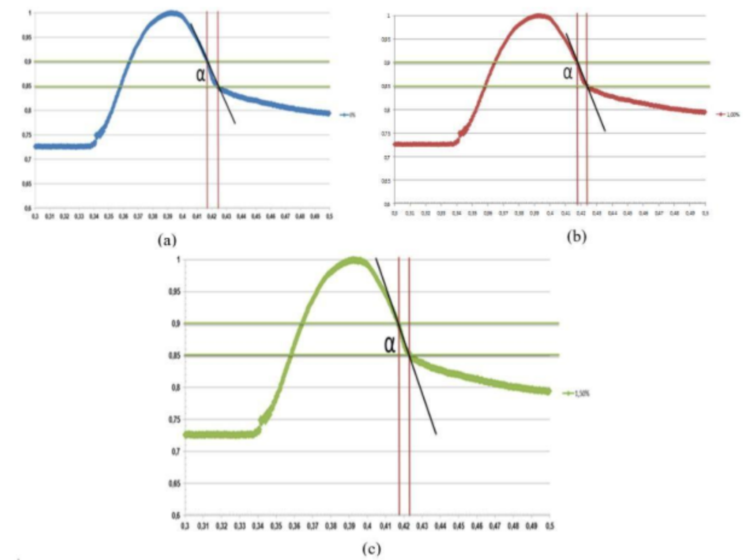

Figure 3. Relationship of Horizontal Deformation Responsibility with a mixture of Polypropylene Plastic (PP) waste levels (a. mixture of PP with 0% varians, b. Mixture of PP with 1% varians, and c. Mixture with 1.5% varians)

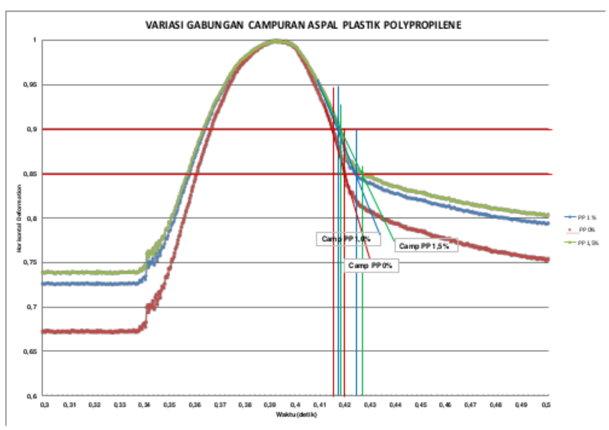

Figure 4. Combined Horizontal Deformation Relationship with a mixture of Polypropylene Plastic (PP) waste levels

4 Conclusion

From the ISTM test results obtained Horizontal Deformation Relations with the condition without a mixture of Polypropylene Plastic Waste (PP) (0%) with the addition of Plasma Polypropylene (PP) waste (1.0%) and the addition of Plasma Polypropylene (PP) waste (1.5%) shown in the picture above, there is an increase in the angle of the erect bushes eating asphalt concrete mixture with Polypropylene (PP) plastic waste getting stiffer. Other results are following:

a. Angle α for plastic waste mixture 0% with Horizontal deformation test results using ITSM test equipment obtained angle α = 34.09 0
b. Angle α for 1.0% plastic waste mixture with Horizontal deformation test results using ITSM test equipment obtained angle α = 41.25 0
c. Angle α for 1.5% plastic waste mixture with Horizontal deformation test results using ITSM test equipment obtained angle α = 42.27 0

References

1. A.I. Al-Hadidy. 2018 .Engineering behavior of aged polypropylene-modified asphalt Pavements, Construction and Building Materials Vol191:187–192.
2. Ahmedzade P, and Yilmaz M. 2008. Effect of Polyester ResinAdditive on The Propertis of asphalt Binders and Mixtures. Contruction and Building Vol 22 : 481 – 486.
3. Airey G.D and Collop A.C. 2015. Mechanical and Structural Assessment of Laboratory-and Field-Compacted Asphalt Mixture. Internasional Jurnal of Pavement Engineering Vol.17, No 1 : 50-63.
4. Takaikaew T dkk. 2018. Performentce of Fiber-Reinforced Asphalt Concreteswith Various Asphalt Binders in Thailand. Journal of Materials in Civil Engineering Vo.30 N0.8 : 04018193.
5. Yan J, dkk. 2010. An Experimental Study on Fatigue Properties of Emulsion and Foam Cold Recycled Mixes. Contruction and Building Materials Vol.24 : 2151-2156.
6. Zoorob S.E and Suparma L.B. 2000. Laboratory Designand Investigation of The Propertie of Continuously Graded Asphaltic Concrete Containing Recycled Plastics Agregate Replacement (Plastiphalt) Cement & Concrete Vol. 22 : 233 – 242.

The Effect of Polypropylene (Pp) Plastıc Waste on Horızontal Deformatıon of Concrete Asphalt

ORIGINALITY REPORT

9%	5%	4%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Tapkın, Serkan. "Optimal polypropylene fiber amount determination by using gyratory compaction, static creep and Marshall stability and flow analyses", Construction and Building Materials, 2013. Publication	3%
2	www.researchgate.net Internet Source	3%
3	Submitted to Temple University Student Paper	2%
4	Ahmedzade, P.. "Evaluation of steel slag coarse aggregate in hot mix asphalt concrete", Journal of Hazardous Materials, 20090615 Publication	2%

Exclude quotes	On	Exclude matches	< 2%
Exclude bibliography	On		

The Effect of Polypropylene (Pp) Plastıc Waste on Horızontal Deformatıon of Concrete Asphalt

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7