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THE INFLUENCES ADDITION OF PET (POLYETHTYLENE TEREPTHALATE) TYPE OF PLASTIC BOTTLE WASTE AS ADDITIVE TO ASPHALT MIX AC-BC

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ABSTRACT

The problem of waste in Indonesia is a problem that has not been resolved until now, especially plastic waste. If there are amount of plastic waste and the plastics are difficult to decompose on the ground and sea, it means the surrounding environment will be polluted. As known that disposable drinking bottle waste is often found in the surrounding environment. Considering the problem above, this study is important to do to see that a lot of plastic bottle waste is wasted and there is no function value. Therefore, the use of plastic as an alternative added material is expected to improve the quality of asphalt concrete pavement. Based on the study, it was found that the addition of PET from variations of 0%, 1%, 1,5%, 2%, 2,5% obtained the appropriate content at 1% variation with a stability value of 1548,59 kg increased on 4,078% from normal asphalt content than without PET mixture. It has better resistance with a VIM value of 4.08% followed by a VMA value of 17,56%, while MQ value with the addition of 1% variation of PET of 288,80 kg/mm with specification of Bina Marga 2018 minimum 250 kg/mm which has met that requirements.

Keywords: AC-BC asphalt, Marshall Characteristics, PET, Highway

1. INTRODUCTION

The waste problem in Indonesia is a problem that has not been resolved until now, meanwhile, with the increase in the number of people, it will also follow the increasing volume of waste heaps produced from human activities. Especially the problem with plastic waste, if more and more of it is in the environment, it will have the potential to pollute the environment, considering that the nature of plastic will decompose in the soil in more than 20 years and can even reach 100 years, thereby reducing soil fertility while on the other hand in plastic waters it will be difficult to decompose {Purwaningrum, 2016).

This research is quite reasonable because the plastic waste often found in plastic drinking bottles waste can only be used once, so there is a dominant buildup. Plastic bottle waste whose disposal is increasingly uncontrolled is becoming a very worrying problem. This type of bottle waste can usually be found with a one-bellied triangle, which is of the type of PET (Polyethylene Terephthalate) plastic.

The Ministry of Public Works and Public Housing (PUPR) continues to develop plastic asphalt mixture technology. The application of plastic asphalt technology is the government's effort in reducing plastic waste. The addition of PET plastic waste can improve the quality of the AC-BC mixture and save road infrastructure construction costs (Purnamasari and Suryaman, 2010).

Asphalt can be modified by using polymers classified into three main groups, namely: elastomers, thermoplastics, plastomers, and reactive polymers. When polymers are added to the mixture it can usually increase the rigidity higher. PET-type polymers are the result of condensation of ethylene glycol and terephthalic acid polymers derived from petroleum and known by the trade name mylar, consisting of ethylene terephthalate monomers with the molecular formula $C_{10}H_8O_4$ (Mujiarto, 2005).

Based on research conducted by Ahmad Faqihul Muqqodam, under the title "Utilization of PET Plastic Waste in AC-BC Mixtures as Eco Material Innovations published by the Proceedings of the 21st Intercollegiate Study Forum Symposium of Universitas Brawijaya in 2018, Study Program of the Department of Infrastructure Engineering, Sepuluh Nopember Institute of Technology. This study uses the wet method. This means that PET is mixed with asphalt at a temperature of 200 °C and then mixed with aggregate. This study used 60/70 penetration asphalt. Optimum asphalt content of 5.8% by weight of asphalt content. While PET is added with 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7% and 8% of the weight of asphalt content. Based on Marshall's test, the addition of 3% PET has 78% higher stability than without PET (Muqoddam *et al*., 2018).

Answering the existing problems, this research is important to see that a lot of plastic bottle waste is wasted and there is no economic value, besides that it can also cause environmental pollution, therefore the use of plastic as an alternative to added materials, is expected to improve the quality of concrete asphalt pavement.

2. LITERATURE REVIEW

2.1 Materials of Asphalt Concrete Binder Course

AC-BC coating is a type of road pavement consisting of a mixture of aggregate and asphalt, with or without added materials. Asphalt concrete for the binding layer or also called the intermediate layer (binder course), is a pavement layer located under the wear layer. It is not directly related to the weather, but it is necessary to have the stability to carry a load of traffic devolved through the wheels of the vehicle. Maximum aggregate size = 25.4 mm and the minimum nominal thickness of AC-BC is 6 cm (S. Sukirman, 2016).

2.2 Aggregate

An aggregate is a combination of sand, gravel, crushed stone, or any other combination of materials used in asphalt concrete mixtures. The proportions of coarse aggregates, fine aggregates, and fillers are based on the specifications and gradations available (Hartantyo and Hermanto, 2019). The amount of aggregate in the asphalt mixture is usually 90 to 95 percent or 75 to 85 percent of the volume. Aggregates can be obtained naturally or artificially (Pratiwi and Hartantyo, 2019).

2.2.1 Coarse Aggregates

Coarse Aggregate is an aggregate with grain size larger than sieve number 8 (2.36 mm). Gravel in its use must meet the following conditions (Kartikasari and Arif, 2019):

Table 1. Coarse Aggregate Specifications

Test	Standard	Grades
Los Angeles abrasion	SNI 2417:2008	Max. 6%
Attachment of the aggregate to asphalt	SNI 2439:2011	Min. 95%
Coarse aggregates angularity	SNI 7619:2012	100/90
Flat and elongated particles	ASTM D4791-10	Max. 5%
Materials passed sieve No. 200	SNI ASTM C117:2012	Max. 1%

Source: Bina Marga 2018

2.2.2 Fine Aggregates

The fine aggregate is all granules passed through a 4.75 mm sieve (S. Arif, 2018). Fine aggregates for concrete can be natural sand, the result of fragments from natural rocks, or in the form of artificial sand produced by stone-breaking machines commonly called stone ash.

Table 2. Fine Aggregates Specifications

Pengujian	Standar	Nilai
Sand equivalent	SNI 03-4428-1997	Min. 50%
Test cavity levels without compaction	SNI 03-6877-2002	Min. 45%
Materials passed sieve No. 200	SNI ASTM C117:2012	Max. 10%

Source: Bina Marga 2018

2.3 Filler

Filler is the most delicate mineral of asphalt concrete aggregate, less than sieve number 200 in size, and should not contain moisture (Prameswari and P. Pratomo, 2016). Best suited for fillers is Portland cement which is moisture-free as it is packed in sacks (Kartikasari and Hartantyo, 2017).

2.4 Properties and Chemical Analysis of PET

Asphalt can be modified by using polymers classified into three main groups, namely: elastomers, thermoplastics, plastomers, and reactive polymers. When polymers are added to the mixture it can usually increase the rigidity higher (Prasetyo and Arif, 2010). PET-type polymers are the result of condensation of ethylene glycol and terephthalic acid polymers derived from petroleum and known by the trade name mylar, consisting of ethylene terephthalate monomers with a molecular formula $C_{10}H_8O_4$ (Maal, 2017).

3. RESEARCH METHOD

The implementation of research such as the manufacture of test objects, maintenance and testing of test objects is carried out in the laboratory of the Civil Engineering Study Program, Faculty of Engineering, Islamic University of Lamongan. The research tested on asphalt concrete – binder course (AC-BC) is Marshall Test for the addition of polyethylene terephthalate (PET) type of plastic bottle waste as an added material for asphalt mixture. All

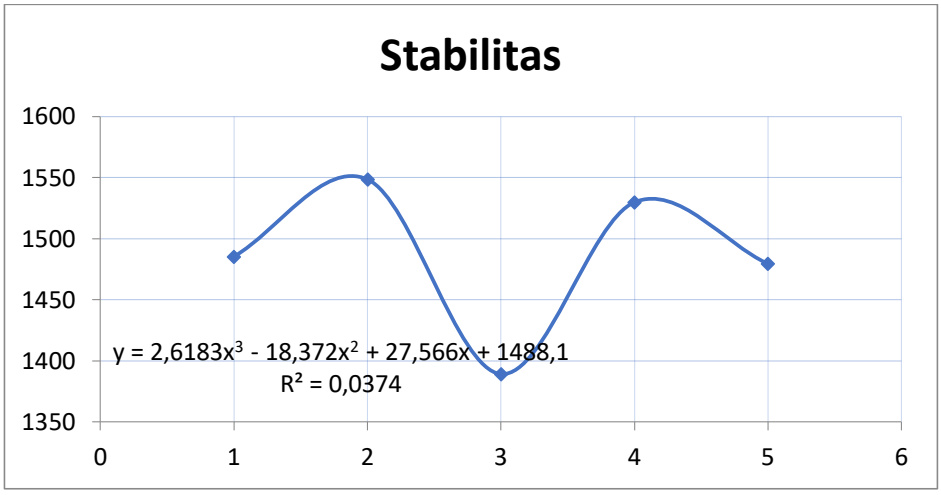
materials used refer to the general specifications used. In this study, the method used is an experimental method that is likely to occur trial and error in its implementation.

3.1 Marshall Method

Testing on mixtures based on the Marshall method was invented by Bruce Marshall. The basic principle of the Marshall method is the study of stability or fatigue (flow), as well as the pore density analysis of the solid mixture formed by Marshall testing, which is the nature of the paved mixture (Sriharyani and Tholib, 2018). The purpose of this test is to determine the stability against the plastic melting (flow) of the asphalt mixture and aggregate (Kartikasari and Arif, 2017).

4. RESULTS AND DISCUSSIONS

4.1 Addition of Plastic Bottle Waste to Stability Value

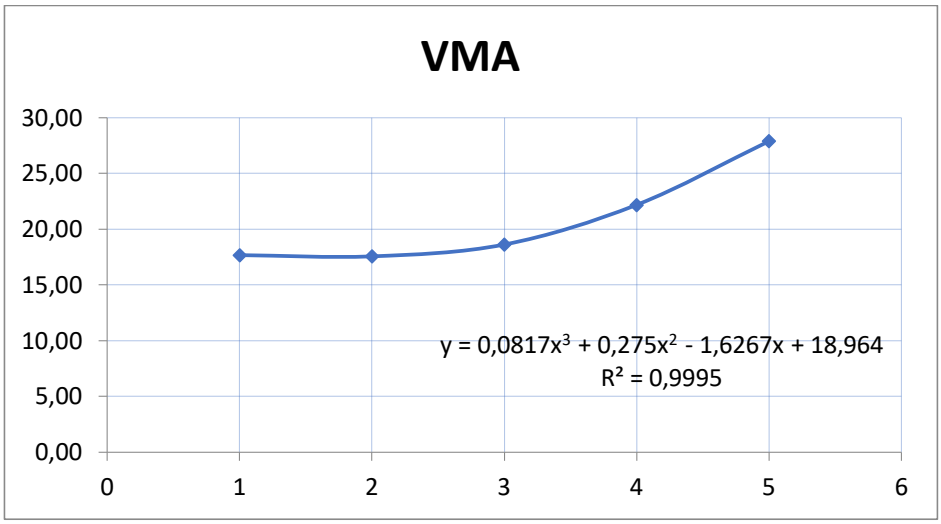


Source: Research Results

Figure 1. Stability Value Graphic

The addition of plastic bottle waste makes the stability value increase at a variation of 1% by 4.078% but in the addition of the next variation of plastic bottle waste experiences ups and downs. So that it can be the highest stability at a variation of 1%.

4.2 Addition of Plastic Bottle Waste to VMA Value

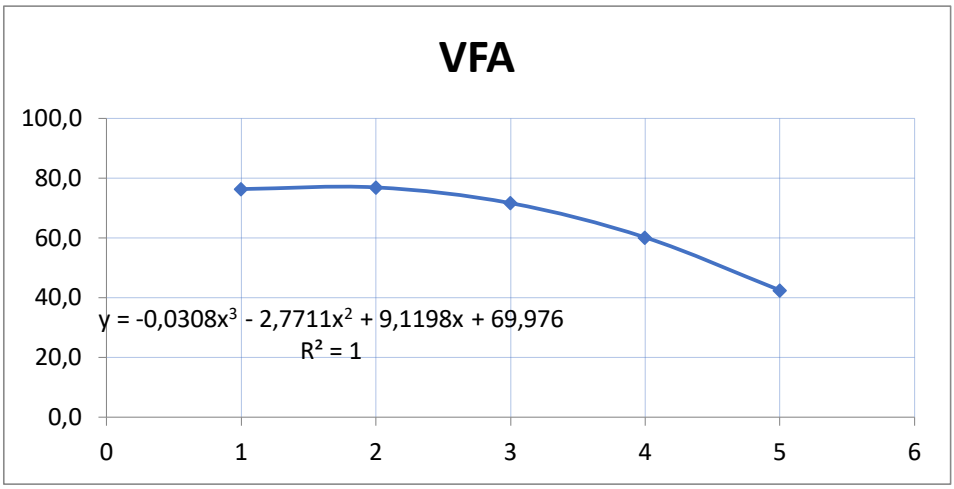


Source: Research Results

Figure 2. VMA Value Graphic

The addition of plastic bottle waste made the value of VMA increase at a variation of 2% by 25.523% and also at a variation of 2.5% by 58.200%, but in a variation of 1% decreased by 623%. This is due to the addition of waste bottles to the 1% variation of the cavities in the aggregate will be small so that the asphalt binds the aggregate well.

4.3 Addition of Plastic Bottle Waste to VFA Value

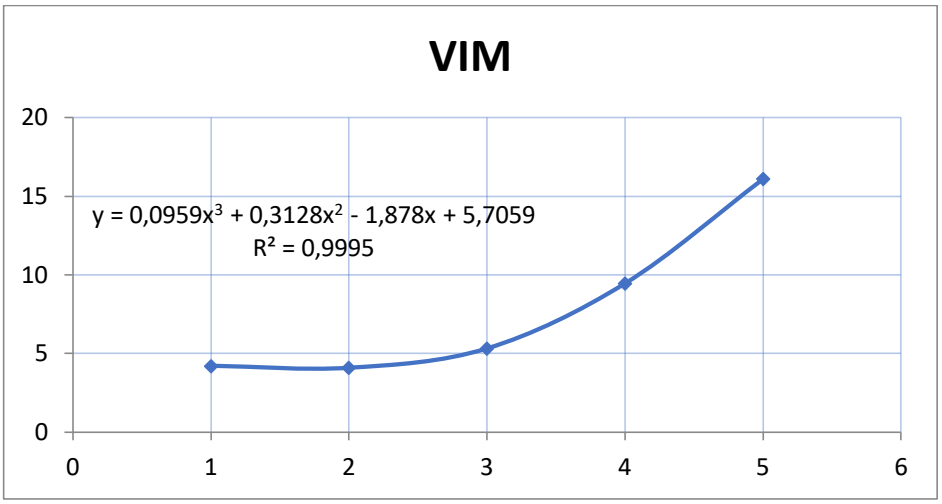


Source: Research Results

Figure 3. VFA Value Graphic

The addition of plastic bottle waste makes the value of VFA decrease along with the addition of variations in plastic bottle waste. This is because as more and more plastic bottle waste is used, the cavities present in the mixture will be covered by added material so that the aggregate is firmly bound by asphalt. The highest VFA value occurred in the addition of a 1% variation of 0.734%.

4.4 Addition of Plastic Bottle Waste to VIM Value

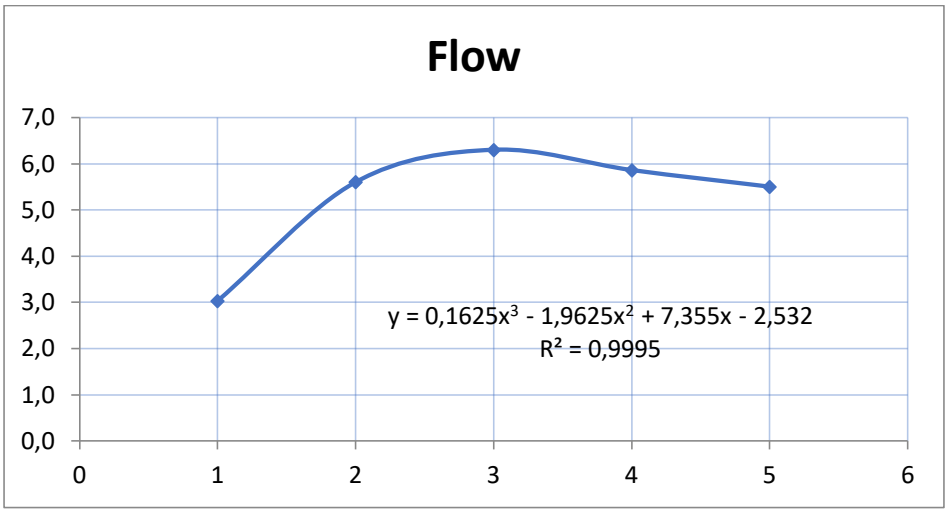


Source: Research Results

Figure 4. VIM Value Graphic

The addition of plastic bottle waste makes the value of VIM increase along with the addition of variations in plastic bottle waste. A significant increase was found in the variation in the mixture of plastic waste by 2.5% to 16.1% but in the standard Bina Marga specification the VIM value was between 3-5%, and the best variation in the addition of plastic bottles was at 1% by 4.08%.

4.5 Addition of Plastic Bottle Waste to Flow Value

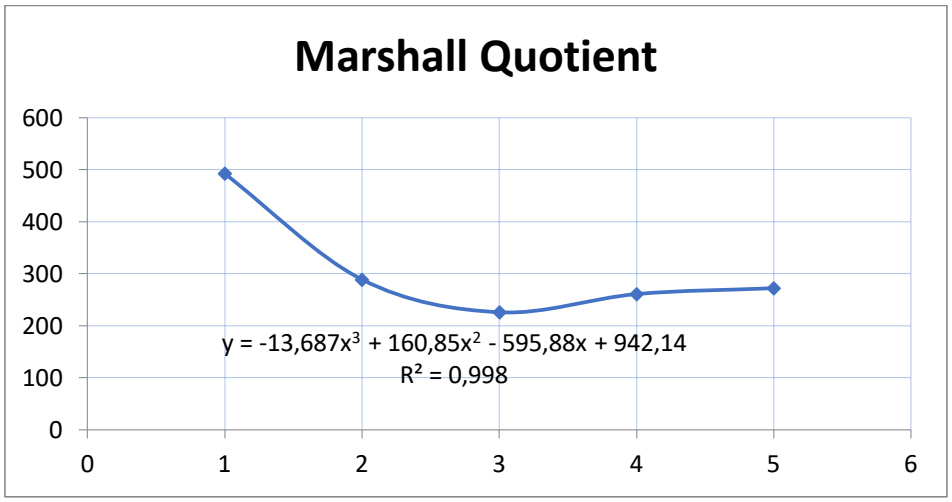


Source: Research Results

Figure 5. Flow Value Graphic

The addition of plastic bottle waste to the flow value does not meet the 2018 Bina Marga specifications. The standard flow value is 2-4 so the addition of plastic bottle waste to the flow value is at an average of 5-6 mm. due to the properties of plastics made from polymers and elastomers, the value of plastic melted or flow becomes greater as the addition of plastic bottle waste.

4.6 Addition of Plastic Bottle Waste to Marshall Quotient Value



Source: Research Results

Figure 5. Flow Value Graphic

The addition of plastic bottle waste to the Marshall Quotient value obtained the highest MQ value was found in the variation in the addition of waste tires within 1% with an MQ value of 288.80 kg / mm. and the lowest MQ value is found at a variable rate of 2% or normal without a mixture of waste inner tubes. According to the specifications of Bina Marga 2018, the minimum MQ value is 250 kg / mm.

5. CONCLUSION

After conducting the study, the results were obtained that the addition of PET from a variation of 0%, 1%, 1.5%, 2%, and 2.5% obtained the right level at a variation of 1% with a stability value of 1548.59 kg increased by 4.078% from the normal asphalt content than without pet mixture so that it has better resistance, with a VIM value of 4.08% followed by a VMA value of 17.56% this value tends to decrease from normal asphalt but with the greater the VIM and VMA values show the lower the attachment of the asphalt mixture because the cavity created will be filled with air or water. Meanwhile, the MQ value with the addition of a 1% variation pet of 288.80 kg / mm, with a minimum 2018 Bina Marga specification of 250 kg / mm has met the requirements. the greater the MQ value indicates that the mixture is less good because it shows the asphalt mixture is getting brittle. However, at flow values that meet the requirements only on normal asphalt, the addition of PET exceeds the maximum requirements. So the addition of PET-type plastic bottle waste to the AC-BC asphalt mixture is considered not to meet the requirements for flow value.

REFERENCES

P. Purwaningrum, “Upaya Mengurangi Timbulan Sampah Plastik Di Lingkungan,” *Indones. J. Urban Environ. Technol.*, vol. 8, no. 2, pp. 141–147, 2016, doi: 10.25105/urbanenvirotech.v8i2.1421.

P. E. Purnamasari and F. Suryaman, “Pengaruh Penggunaan Limbah Botol Plastik Sebagai Bahan Tambah Terhadap Karakteristik Lapis Aspal Beton (Laston),” *Konf. Nas. Tek. Sipil 4*, vol. 4, no. 4, pp. 1–7, 2010.

I. Mujiarto, "Sifat dan Karakteristik Material Plastik dan Bahan Aditif," *Traksi*, vol. 3, no. 2, pp. 65–74, 2005.

A. F. Muqoddam *et al.*, "Pemanfaatan Limbah Plastik PET (*polyethylene terephthalate*) pada Campuran AC-BC (*asphalth concrete – binder concrete*) Sebagai Inovasi Eco-Material, pp. 19–20, 2018.

S. Sukirman, Perkerasan Lentur Jalan Raya *2016*.

S. D. Hartantyo and B. Hermanto, "Pengaruh Penggunaan Krikil Mantup Sebagai Bahan Perkerasan Jalan" vol. 3, no. 2, pp. 140–149, 2019.

W. D. Pratiwi and S. D. Hartantyo, "Pengaruh Kekuatan Campuran Aspal Panas Laston Tipe Iv Sni 03-1737-1989 Akibat Penambahan Serat Eceng Gondok," vol. 4, no. 1, pp. 248–255, 2019.

D. Kartikasari and S. Arif, "Pengaruh Penambahan Limbah Plastik Pada Campuran," *Seniati 2018*, pp. 334–338, 2019.

S. Arif, "Alternatif Penggunaan Plastik Polypropylene Pada Campuran Aspal," *J. CIVILA*, vol. 3, no. 1, p. 140, 2018, doi: 10.30736/cvl.v3i1.221.

P. A. Prameswari and P. Pratomo, "Pengaruh Pemanfaatan PET pada Laston Lapis Pengikat Terhadap Parameter Marshall," vol. 4, no. 2, pp. 294–305, 2016.

D. Kartikasari and S. D. Hartantyo, "Penggantian Filler Dengan Fly Ash Dan Serbuk Batu Bata Pada Campuran Aspal (Ac-Wc)," *UKaRsT*, vol. 1, no. 1, p. 9, 2017.

H. Prasetyo and S. Arif, "Studi Pencampuran Serat Eceng Gondok Sistem Hot Rolled Sheet Bc Spesifikasi Seksi-6 : 2010 Bina Marga," *J. CIVILA*, vol. 3, no. 2, p. 146, 2018, doi: 10.30736/cvl.v3i2.256.

A. Maal, "Kinerja Struktural, Durabilitas dan Ketahanan Terhadap Deformasi Plastis Aspal Beton Menggunakan Bubuk Botol Plastik Sebagai Filler," pp. 127–136, 2017.

L. Sriharyani and A. Tholib, "Perubahan Parameter Marshall Akibat Perbedaan Jumlah Tumbukan pada Asphalt Concrete-Binder Coarse (AC-BC) Gradasi Kasar," vol. 8, no. 1, pp. 53–65, 2018.

D. Kartikasari and S. Arif, "Meningkatkan Index Properties of Marshall Pada Campuran Laston Tipe I Sni 03-1737-1989," 2017.