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CHARACTERISTICS THE MARSHALL TEST SUBSITUTUTION OF POLYPROPYLENE PLASTIC PELLETS AS FILLER IN MIXTURE ASPHALT CONCRETE BINDER COURSE (AC BC)

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Abstract : This research was carried out on a laboratory experimental scale, with the aim of determining the characteristics of the Marshall test for the substitution of Polypropylene plastic pellets in the Asphalt Concrete Binder Course (AC BC) mixture. The substitution of Polypropylene plastic pellets in AC BC mixture is 1%, 2%, 3% of the weight of filler in AC BC standard mixture. From the test results, it can be concluded that the characteristics of the marshall test include VMA values, VIM values, VFA values, stability values, flow values, MQ values that meet the predetermined requirements both without filler and with filler.

Keywords: *Marshall test, Polypropylene,Filler, VMA,VIM,VFA,Flow, MQ, AC BC*

INTRODUCTION

With very rapid development and population growth. In this regard, it has resulted in a high increase in population mobility. So that there are a large number of vehicles, both light, medium, and heavy vehicles passing on the highway. One of the means of transportation is the road which is a basic need and supports community activities. By seeing the increase in population mobility growth is very high, it is necessary to increase both the value of the structure and the quality of the quality, roads used to meet the activities and activities of the population's needs.

Hot mixed concrete asphalt is one type of bending pavement construction pavement layer. This type of pavement is an even mixture of aggregate and asphalt as a binding material at a certain temperature. To dry the aggregate and get enough liquidity from the asphalt so that it is easy to mix it, the two materials must be heated before mixing. The characteristics of asphalt concrete are much influenced by the materials used for the mixture, the gradation of the mixture and good implementation in the field, while the strength of asphalt concrete is largely determined by the rocks that in the process of mixing (composition) greatly determine the characteristics of the asphalt concrete. To improve the ability and a pavement is with certain materials both on asphalt and on agreagat [1].

Pavement must be well planned in accordance with applicable standards in Indonesia [2]. Asphalt layer concrete is one type of bending pavement with the most use in Indonesia. This layer is composed of coarse aggregate, fine aggregate, and asphalt [3]. This study is a laboratory experimental study, with the aim of the study is to determine the characteristics of the Marshall Test substitution of

[1] Ainaya Sulistyaningsih et al., “KARAKTERISTIK MARSHALL TERHADAP PENGGUNAAN ASBUTON BUTIR B5/20 DENGAN SUBSTITUSI DASPAL DAN ASPAL PENETRASI 60/70,” *Bangun Rekaprima: Majalah Ilmiah Pengembangan Rekayasa, Sosial Dan Humaniora* 8, no. 2, Oktober (2022): 51–58.

[2] Philipus Resato Nahak, Yosef Cahyo, and Sigit Winarto, “Studi Perencanaan Tebal Perkerasan Konstruksi Jalan Raya (Menggunakan Metode Bina Marga) Pada Ruas Jalan Umasukaer Di Kabupaten Malaka,” *Jurnal Manajemen Teknologi & Teknik Sipil* 2, no. 1 (2019): 75–85.

[3] Angga Pirman Firdaus, “PENGARUH PENGGUNAAN LIMBAH PLASTIK POLYPROPYLENE (PP) SEBAGAI CAMPURAN AGREGAT KASAR TERHADAP KUAT TEKAN DAN TARIK PADA BETON FC’25 MPA,” *Jurnal Infrastruktur* 3, no. 2 (2017): 81–89.

polypropylene plastic pellets as fillers in the AC BC mixture. This type of plastic pellet is one type of thermoplastic polyethylene plastic that is widely used in everyday life. Polypropylene plastic is one type of thermoplastic plastic, where this type of plastic can be developed as a material in buildings, because it is easily recycled, the plastic pellets used in this study recycled plastic pellets purchased directly at the material store are in the form of granules and clear white in color[4].

Asphalt is a dark brown or unconcentrated hydrocarbon compound formed from asphalthenes, resins and oils. Asphalt in the pavement layer serves as a binding material between aggregates to form a compact mixture, so that it will provide strength for each aggregate. Apart from being a binding material, asphalt also serves to fill the cavity of aggregate granules and existing pores of the aggregate itself. Fillers can use stone dust. The filler must be dry and free of lumps and is a material that 75% passes sieve no. 200 and has non-plastic properties [5]. Laston as a binder material, known as AC BC (Asphalt Concrete Binder Course). This layer is part of the surface layer between the upper foundation layer (Base Course) and the wear layer (Wearing Course) which is graded with a combined aggregate / continuous, generally used for roads with heavy traffic loads [6].

Regional Geology

a. Asphalt

Asphalt is a dark brown or unconcentrated hydrocarbon compound formed from asphalthenes, resins and oils. Asphalt in the pavement layer serves as a binding material between aggregates to form a compact mixture, so that it will provide strength for each aggregate. Apart from being a binding material, asphalt also serves to fill the cavity of aggregate granules and existing pores of the aggregate itself [7].

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[4] Firdaus.

[5] Departemen Pekerjaan Umum and Perumahan Rakyat, "Direktorat Jenderal Bina Marga," *Pengaspalan, Badan Penerbit Pekerjaan Umum*, 1997.

[6] Departemen Pekerjaan Umum, "Direktorat Jenderal Bina Marga, 1997," *Manual Kapasitas Jalan*, 1987.

[7] Hamid Muhammad, *Direktorat Pembinaan Sekolah Menengah Kejuruan Direktorat Jenderal Pendidikan Dasar Dan Menengah Kementerian Pendidikan Dan Kebudayaan Republik Indonesia*, n.d.

b. Characteristics of Asphalt Concrete

There are 7 (seven) characteristics of the mixture that must be owned by asphalt concrete [8] as follows:

(1) Stability.

The stability of the road pavement layer is the ability of a road pavement to receive traffic loads without changes in shape such as waves, wheel grooves and rising asphalt surfaces. Stability that is too high causes the layer to become stiff and quickly crack, in addition because the volume between aggregates is less resulting in low levels of asphalt needed. Stability occurs from the result of friction between grains, locking between particles, good bonding of asphalt coatings

(2) Durability

Durability is the resistance of the surface layer to the influence of weather, water and temperature changes as well as vehicle wheel friction wear. High durability is generally achieved with high asphalt content, tight agreagat gradation and good compaction.

(3) Flexibility (flexibility)

Flexibility is the ability of the surface layer to be able to follow the deformation that occurs due to repeated traffic loads without the onset of cracks and other changes.

(4) Skid resistance.

Shear resistance is the toughness provided by pavement, so that the vehicle does not slip when it rains or gets wet dry. Tightness is expressed by the coefficient of friction between the road surface and vehicle tires

(5) Waterproof (impermeability)

Impermeability is the ability of the pavement surface to resist water seepage into the surface so as to provide protection against construction in the lower layer.

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[8] Sulistyaningsih et al., "Karakteristik Marshall Terhadap Penggunaan Asbuton Butir B5/20 Dengan Substitusi Daspal Dan Aspal Penetrasi 60/70."

(6) Workability
It is easy for a mixture to be spread and compacted so that results are obtained that meet the expected density.

c. **Fatique resistance.** It is the resistance of the asphalt layer in accepting repeated loads without melting in the form of grooves (ruting) and cracks.

d. **Aggregate.** Aggregates are mineral particles in the form of granules which are one of the uses in combination with various types ranging from as materials in cement to form concrete, road foundation layers, filler materials and others. In general, the aggregate used in paved mixtures is divided into two fractions [9], namely:

1) Coarse aggregate
The coarse aggregate fraction for mixed design is that held by sieve No. 4 (4.75 mm) which is wet carried out and must be clean, hard, durable and free of clay or other undesirable materials and meet the requirements. Aggregate used Fine aggregate.

2) Fine Aggregate
The fine aggregate fraction is a material that passes filter No. 4 (4.175 mm) and resists sieve No. 200 (0.075 mm).

e. **Marshall Method.** The basic principle of the marshall method is the stability and meltdown (flow) check as well as the density and pore analysis of the solid mixture formed [10].

1) Specific Gravity/Bulk Density
Density is the weight of the mixture measured per unit volume, density indicates the level of density of the mixture after solidification. Factors affecting density are the quality of the constituent materials, compaction energy and asphalt content in the mixture. The results of research in the laboratory can be valued as follows. With the higher the density value, the quality of the mixture will be obtained that is good. This can be

[9] Silvia Sukirman, "Perkerasan Lentur Jalan Raya," 1999.

[10] Nyoman Martha Jaya, AAGA Yana, and IWGE Triswandana, "Penerapan Rekayasa Nilai Pada Proyek Pembangunan Gedung Sekolah (Studi Kasus Pembangunan Gedung Sekolah Sanur Independent School)," *Jurnal Spektran* 7, no. 1 (2019): 244–53.

explained by the high density of a hot asphalt mixture will be more water and air sensitive.

2) Void In Mineral Aggregate (VMA)

Air voids in aggregate (VMA) are the number of pores between aggregate granules in an asphalt mixture expressed as a percentage. The value of the air cavity in a small aggregate can cause the asphalt that covers the aggregate to be limited so that then the aggregate is released making the layer not watertight, oxidation easily occurs so that the pavement layer is easily damaged.

3) Void In The Mix (VIM)

The value of the air cavity in the mixture indicates the number of cavities present in the mixture. The value of the air cavity in the mixture affects the impermeability properties of the mixture. The value of air cavities in a large mixture indicates the number of cavities in the mixture so that the mixture is less dense or less impermeable to water or air so that young oxidation occurs. If the value of the air cavity in the mixture is small, it indicates that the mixture is too tight or dense and has high stiffness which will result in rising asphalt surface (bleeding) due to compaction by traffic loads occurring and shifting the asphalt surface (sliding).

4) Void Filled with Bitumen (VFB)

The asphalt filled air cavity (VFB) indicates the percentage of voids in the asphalt-filled mixture. The value of the asphalt filled air cavity determines the stability, durability and flexibility value of the mixture which is influenced by aggregate gradation, compaction temperature, asphalt content, asphalt type and compaction energy.

f. **Stability.** The stability value is the ability of the layer to accept traffic loads without changes in grooves, ruts, waves and bleeding on the pavement. Things that affect the AC-WC mixture are friction, interlocking properties, material shape and are also influenced by aggregate surface texture, aggregate gradation, particle shape, mixture density and asphalt viscosity.

1) Fatigue

The melting value expresses the amount of deformation or decrease of the compacted mixture, which is due to the large load working on it and indicates the degree of flexibility of a pavement. The melting value is influenced by asphalt factor, asphalt viscosity, gradation, aggregate aggregate surface texture and compaction rate.

2) Marshall Quetient.

   The value of the marshall quotient is influenced by the quotient between corrected stability and the melting value. This quotient value is used as an approximation to the degree of stiffness or flexibility of a mixture. The greater the yield value for the marshall, the more rigid a mixture will be. The smaller the yield value for the marshall, the more flexible the mixture will be.

RESEARCH METHODS

This research was conducted experimentally in the Asphalt laboratory of PT. Komba Mahaka Utama Martapura OKUT. In this study, a mixture of AC-BC (Asphalt Concrete-Binder Course) was used as a mixture, fine aggregate was taken from AMP Komba Mahaka Utama OKUT, while coarse aggregate, and rock ash used in the form of natural stone were carried out by the process of breaking crushed stone from the process of breaking the AMP crusher machine (Asphalt Mixing Plan) PT. Komba Mahaka Utama. Polypropylene Plastic Pellets (white butitan) are used as a substitute for fillers in AC BC mixtures. The testing stages in this study consist of aggregate testing (coarse, fine and filler), asphalt testing and testing of mixtures, namely the marshall test. AC BC blends are made with standard mixtures (without the addition of Polypropylene plastic pellets and with Polypropylene plastic pellets). For the addition of Polypropylene plastic pellets by 1%, 2%, 3% of the weight of filler and at optimum asphalt conditions in standard mixtures. Overall AC BC mix is made consisting of: standard AC BC, AC BC addition of 1%, 2%, 3% Polypropylene plastic pellets.

For testing AC BC mixtures used the marshall method as a testing method. The results of the test are marshall characteristics, namely Void in The Mix (VIM), Void in The Mineral Aggregate (VMA), Void Filled with Asphalt (VFA), stability, flow, Marshall Quoetion (MQ) and Density. The research flow chart can be seen in Figure 1.

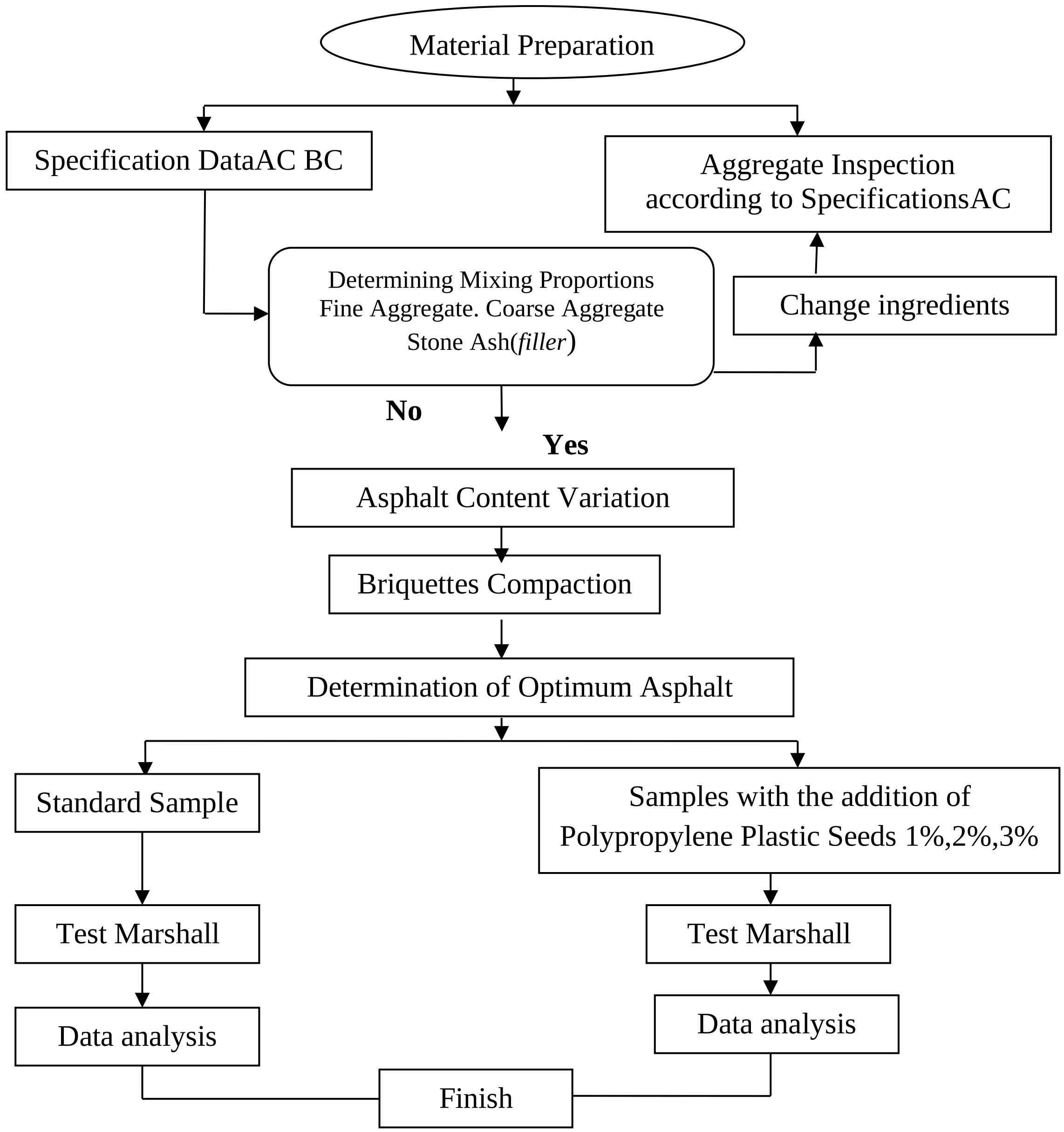

Figure 1 Research Flow Chart

RESEARCH RESULT

1. Research Results

The results of the inspection of AC BC (*Asphalt Concrete Binder Course*) mixture materials in this study are presented in the following table [11]:

Table 1 AC BC Mixed Aggregate Inspection Results

Material Type	Value	
Fine Aggregate Fill Weight	Loose	1,501 gr/cc
	Dense	1,629 gr/cc
Coarse Aggregate Fill Weight	Loose	1,321 gr/cc
	Dense	1,506 gr/cc
Weight of Stone Ash Contents	Loose	1,522 gr/cc
	Dense	1,675 gr/cc
Specific Gravity of Asphalt	1,034 gr/cc^3	
Asphalt Lember Point	51,8 ^{o}C	
Flash Point of Asphalt	358 ^{o}C	
Ductility of Asphalt at temperature 25 ^{o}C	>140	
Optimum Levels of Asphalt in Campura AC BC	5,50 %	

Table 2 Composition of *Marshallese* Briquette Mixture Without *Filler*

Mixture	Percent Mixture	Heavy (kg)	Cumulative (kg)
Broken stone 1/2	20% ×1128	225.60	225.60
Broken stone 1/1	22%×1128	248.16	473.76
Rock ash	48%×1128	541.44	1015.20
Sand	10%×1128	112.80	1128
Filler	0%	0	0
Asphalt	5,50%×1200	66	1194

[11] Asri Nurdiana, "Analisis Biaya Tidak Langsung Pada Proyek Pembangunan Best Western Star Hotel & Star Apartement Semarang," *Teknik* 36, no. 2 (2015): 105–9.

Table 3 Composition of Marshall Briquette Mixture with Plastic Pellet Filler*Polypropylene*1%

Mixture	Percent Mixture	Heavy (kg)	Cumulative (kg)
Broken stone 1/2	20% ×1128	225.60	225.60
Broken stone 1/1	22%×1128	248.16	473.76
Rock ash	48%×1128	541.44	1015.20
Sand	9%×1128	101.52	1116,71
Plastic Pellet Filler	1%×1128	11,28	1128
Asphalt	5,50%×1200	66	1194

Table 4 Composition of Marshall Briquette Mixture with Plastic Pellet Filler*Polypropylene* 2%

Mixture	Percent Mixture	Heavy (kg)	Cumulative (kg)
Broken stone 1/2	20% ×1128	225.60	225.60
Broken stone 1/1	22%×1128	248.16	473.76
Rock ash	48%×1128	541.44	1015.20
Sand	8%×1128	90.24	1105,44
Plastic Pellet Filler	2%×1128	22,56	1128
Asphalt	5,50%×1200	66	1194

Table 5 Composition of Marshall Briquette Mixture with *Plastic Pellet* Filler*Polypropylene* 3%

Mixture	Percent Mixture	Heavy (kg)	Cumulative (kg)
Broken stone 1/2	20% ×1128	225.60	225.60
Broken stone 1/1	22%×1128	248.16	473.76
Rock ash	48%×1128	541.44	1015.20
Sand	7%×1128	78,96	1094,16
Plastic Pellet Filler	3%×1128	33,84	1128
Asphalt	5,50%×1200	66	1194

Table 6 Marshall Test Results

Variations *Filler*	Fill weight (gr/cm³)	Percent cavity to aggregate (%) (VMA)	Percent cavity to mixture (%) (VIM)	Percent cavity Filled with asphalt (%) (VFA)	Stabilitas (kg)	Flow (mm)	Marshall quotient (Kg/mm)
NoFiller							
0%	2,289	16,58	4,52	73,58	1355	3,27	414,37
FillerPlastic PelletsPolypropylene							
1%	2,292	16,21	4,29	74,04	1220,20	3,05	400,07
2%	2,297	16,02	4,11	74,75	1175,00	2,97	395,62
3%	2,300	15,30	3,69	76,02	988,60	2,81	351,81

1. Discussion

Specific Gravity/*Bulk Density*

Density is the weight of the mixture measured per unit volume, density indicates the level of density of the mixture after solidification. Factors affecting density are the quality of the constituent materials, compaction energy and asphalt content in the mixture. The results of research in the laboratory can be valued as shown below:

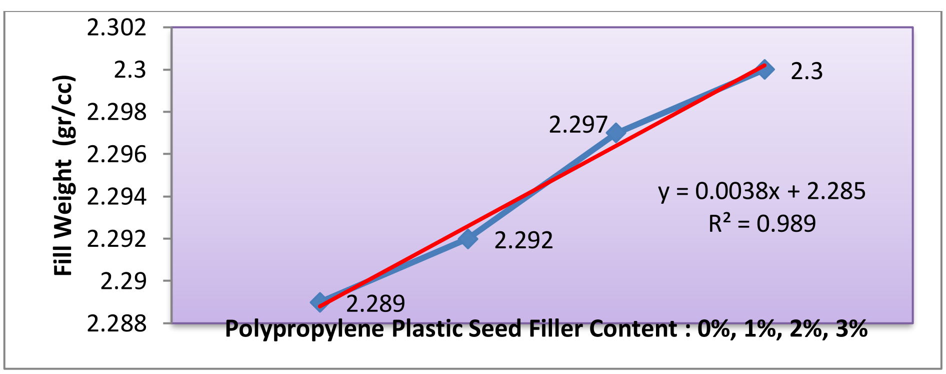

Figure 2 Comparison graph of ACBC *bulk values* with varying levels of *Polypropylene Plastic Pellet Filler*

From figure 2 for a mixture of *normal AC BC* without filler *with variations in* Polypropylene plastic pellet filler levels. The highest density was obtained in the use *of* 3% Polypropylene plastic pellet filler with a value of 2,300 gr/cm³ for *AC BC* asphalt penetration of 60/70. Meanwhile, in a market without using filler with a value of 2.289 gr/cm³ for *AC BC* asphalt penetration of 60/70. For the weight of the contents there are no special requirements issued by Bina Marga regarding this density. With the higher the density value, the quality of the mixture will be obtained that is good. This can be explained by the high density of a hot asphalt mixture will be increasingly water- and airtight [12].

The regression model in figure 2 is a simple linear regression for the value of AC BC Fill Weight with the equation Y = 0.003x + 2.285 from this equation it can be seen that the positive value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X) [13], meaning that if the addition of *Polypropylene Plastic Pellet filler* increases, it will cause an increase in the value of AC BC Fill Weight. For the value of R2 = 0.989, it shows that the effect of adding *Polypropylene* plastic pellet *filler* has an effect of 98.90% increase in the specific gravity of AC BC.

Void In *Mineral Aggregate (VMA*)

Air voids in aggregate (*VMA*) are the number of pores between aggregate granules in an asphalt mixture expressed as a percentage. The value of the air cavity in a small aggregate can cause the asphalt that covers the aggregate to be limited so that then the aggregate is released making the layer not watertight, oxidation easily occurs so that the pavement layer is easily damaged. From the test results in can be values as shown in the following picture:

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[12] Umum and Rakyat, "Direktorat Jenderal Bina Marga."

[13] A Mulyadi, "A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture," in *IOP Conference Series: Materials Science and Engineering*, vol. 209 (IOP Publishing, 2017), 12088.

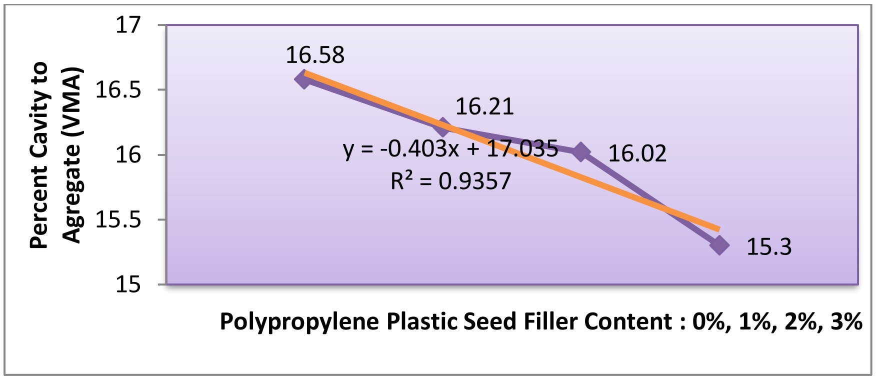

Figure 3 Comparison graph of air cavity values in aggregate (*VMA*)
AC BC* with variations of *Polypropylene* Plastic Pellet *filler

From figure 3 it can be seen that the deep air cavity in the aggregate with the highest value is found in a mixture without filler with a value of 16.58% then in *1*% Polypropylene Plastic Pellet filler with a value of 16.21 %, for 2% with a value of 16.02% while the lowest value is found in 3% *PolypropylenePlastic Pellet* filler with *a value of 15.30* %. For the use of *Polypropylene* Plastic Pellet filler *and without* air cavity *filler* in aggregate still meets the 2018 revision 2 specification required is >15% [14]. The value of the air cavity in the aggregate will determine the durability of the pavement layer, the low value of *VMA is likely due to the melting of* Polypropylene *plastic pellets due* to an increase in temperature in the BC AC mixture so that it adds to cover the air cavity in the aggregate.

The regression model in figure 3 is a simple linear regression for the VMA value in the *AC BC mixture with the equation Y = -0.403x + 17.03 from this equation it can be seen that the minus value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X)* [15], *meaning that if the addition of* Polypropylene Plastic Pellet filler *increases, it will cause a decrease in the* VMA value in a mixture of AC BC. For the value of R2 = 0.935, it shows that the effect of adding *Polypropylene* plastic pellet filler has an effect of 93.50% decrease in the value of air cavities in aggregate (*VMA*) in the AC BC mixture.

Void *In The Mix (VIM*)

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[14] Kementerian Pekerjaan Umum, "Peraturan Menteri Pekerjaan Umum Nomor 13 Tahun 2011 Tentang Tata Cara Pemeliharaan Dan Penilikan Jalan," *Jakarta: Kementerian Pekerjaan Umum*, 2011.

[15] Mulyadi, "A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture."

The value of the air cavity in the mixture indicates the number of cavities present in the mixture. The value of the air cavity in the mixture affects the impermeability properties of the mixture. The value of air cavities in a large mixture shows the number of cavities in the mixture so that the mixture is less dense or less impermeable to water or air so that young oxidation occurs. If the value of the air cavity in a small mixture indicates that the mixture is too tight or dense and has high stiffness which will result in rising *surface asphalt (bleeding*) due to compaction by traffic loads occurring and shifting the asphalt surface *(sliding)* [16]. From the test results in can be presented values as shown in the following picture:

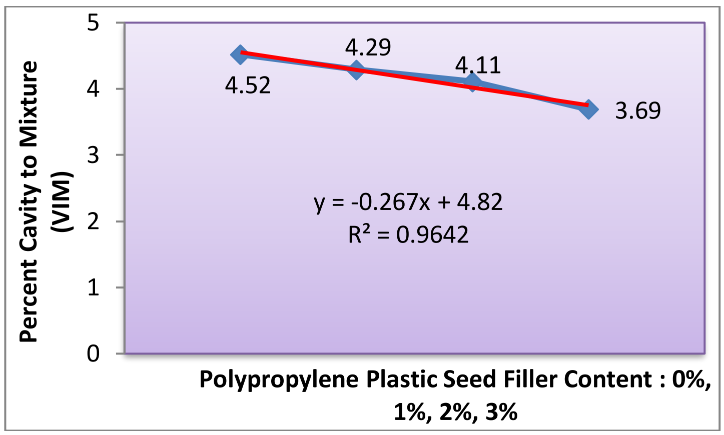

Figure 4 Comparison graph of air cavities in mixture (VIM) values *AC BC* with variations of *Polypropylene Plastic Pellet* filler

From figure 4 it can be seen that the value of the air cavity in the mixture (*VIM*) there is a decrease in value change with the addition of Polypropylene *Plastic Pellet* filler when compared to without *filler* in the *AC BC mixture*. Changes in the decrease in the value of air cavities in the mixture (*VIM*) along with changes in the use of *Polypropylene* plastic pellet *fillers* that vary in the container. AC *BC mixture* without *filler obtained a value of 4.52%, while the addition of 1% Polypropylene* plastic pellet filler obtained a value of 4.29% and in 2% filler obtained a value of *4.11% then in 3%* filler obtained a value of 3.69 %. Overall, the value of air cavities in the mixture (*VIM*) that meets the 2018 revision 2 specification the required value is 3.0% – 5.0% [17]. In a mixture, there

[16] Umum, "Direktorat Jenderal Bina Marga, 1997."
[17] Umum, "Peraturan Menteri Pekerjaan Umum Nomor 13 Tahun 2011 Tentang Tata Cara Pemeliharaan Dan Penilikan Jalan."

must be enough cavities filled with air whose function is to provide space for mixed elements according to their elastic properties, there is a low VIM value *in the AC BC mixture due to the possibility of* Polypropylene *plastic pellets melting due* to an increase in temperature in the AC BC mixture so as to increase the air cavity cover in the AC BC mixture.

The regression model in figure 4 is a simple linear regression for the VIM value in the AC BC mixture with the equation Y = -0.267x + 4.82 from this equation it can be seen that the minus value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X) [18], meaning that if the addition of *Polypropylene* Plastic Pellet filler increases, it will cause a decrease in *the VIM value* in a mixture of AC BC. For the value of R2 = 0.964, it shows that the effect of adding *Polypropylene plastic pellet filler* has an effect of 96.40% decrease in the value of air cavities in the AC BC mixture (*VIM*).

V*oid Filled with Asphalt (VFA*)

The asphalt filled air cavity (*VFA*) shows the percentage of voids in the asphalt-filled mixture. The value of asphalt filled air void determines the value of stability, durability and flexibility of the mixture which is influenced by aggregate gradation, compaction temperature, asphalt content, asphalt type and compaction energy. From the test obtained the following results:

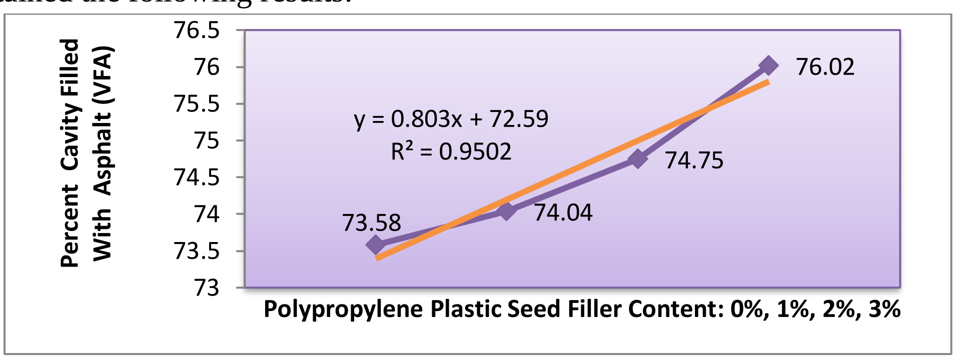

Figure 5 Comparison graph of AC-BC asphalt filled air cavity *(VFA) values* with variations of *Polypropylene* Plastic Pellet *filler*.

From figure 5 it can be seen that the *VFA* value of mixtures without using *fillers*, *or those using* Polypropylene *Plastic Pellet* fillers still meets the requirements of the 2018

[18] Mulyadi, "A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture."

revision 2 specification with a limit of >65%. The mixture without *filler* obtained a value of 73.58%. Meanwhile, the highest value of *VFA* is found in 3% *Polypropylene* Plastic Pellet *filler* with a value of 76.02%. As for the lowest *value using 1% Polypropylene Plastic Pellet filler, the value was 74.04%* and was not too much different from using 2% Polypropylene Plastic Pellet filler, which was 74.75 %. The value of the air cavity filled with asphalt is closely related to the stiffness of the mixture bond, the impermeability of the mixture to water and air, as well as the elasticity of the mixture which determines the strength and resistance of the groove in the coating.

The regression model in figure 5 is a simple linear regression for the VFA value of AC *BC with the equation Y = 0.803x + 72.59 from this equation it can be seen that the positive value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X) [8], meaning that if the addition* of Polypropylene Plastic Pellet filler *increases, it will cause an increase in* the value of VFA. For the value of R2 = 0.950, it shows that the effect of adding *Polypropylene* plastic pellet *filler* has an effect of 95.00% increase in *the value of VFA* AC BC.

Stabilitas Marshall (*Marshall Stability*)

The stability value is the ability of the layer to accept traffic loads without changes in grooves, ruts, waves and bleeding on the pavement. Things that affect AC *BC* mixture are friction, interlocking properties, material shape and are also influenced by aggregate surface texture, aggregate gradation, particle shape, mixture density and asphalt viscosity. From the test results obtained values as presented in the following image:

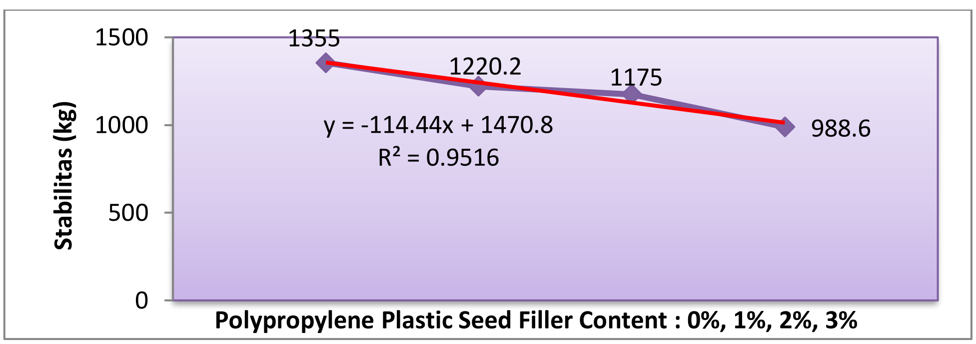

Figure 6 Comparison graph of *AC BC stability values* with variations of *Polypropylene* Plastic Pellet *filler*

From figure 6, it can be seen that the stability value *of the AC BC* mixture with no filler or with Polypropylene plastic pellet filler as a whole still meets the requirements of the 2018 revision 2 specification with a value of > 800 kg. The stability value without filler was 1355 kg, the stability value of adding Polypropylene plastic pellet filler decreased consecutively to 1% with a value of 1220.20 kg, to 2% to 1175 and the smallest value of 3% to 988.60 kg.

The regression model in figure 6 is a simple linear regression for the stability value in the AC BC mixture with the equation Y = -114.24x + 1470 from this equation it can be seen that the minus value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X) [8], meaning that if the addition of *Polypropylene* Plastic Pellet filler increases, it will cause a decrease in the *Stability value* in a mixture of AC BC. For the value of R2 = 0.951, it shows that the effect of adding *Polypropylene* plastic pellet filler has an effect of 95.10% decrease in the value of Stability in the AC BC mixture.

Melt (*Flow*)

The flow value expresses the amount of deformation or decrease of the compacted mixture, which is due to the large load working on it and indicates the degree of flexibility of a pavement. The melting value is influenced by asphalt factors, asphalt viscosity, gradation, aggregate aggregate surface texture and compaction rate [19].

The required *flow* value is 2.0 to 4.0 if the melting value is less than 2.0 causing the mixture to crack and groove easily due to rigidity. From the results of the study obtained results as in the following picture:

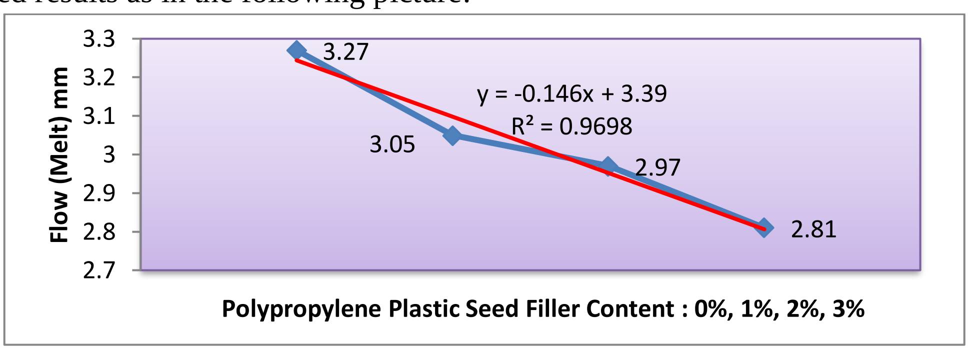

Figure 7 Comparison graph of *AC BC melting values* with variations of *Polypropylene* Plastic Pellet *filler*

From figure 7, it can be seen that the highest melting value is in a mixture without filler, which is with a value of *3.27 mm, while the lowest value in the use* of 3% Polypropylene *Plastic Pellet* filler is with a value of 2.81 mm. For *1% Polypropylene*

[19] Umum, "Direktorat Jenderal Bina Marga, 1997."

plastic pellet *filler* of 3.05 and 2% with a value of 2.97 mm. Overall for the melting value in the mixture of *AC BC* without *filler, and* filler *Polypropylene* plastic pellets *meet the requirements of the 2018 revision 2 specification with a value of 2.0 – 4.0 mm.*

The regression model in figure 7 is a simple linear regression for the *stability value in the* AC BC mixture with the equation Y = -0.146x + 3.99 from this equation it can be seen that the minus value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X) [8], meaning that if the addition *of Polypropylene* Plastic Pellet filler increases, it will cause a decrease in the value of melt (*flow*) in the BC AC mixture. For the value of R2 = 0.969, it shows that the effect of adding *Polypropylene* plastic pellet filler has an effect of 96.90% decrease in the value of melt (*flow*) in the AC BC mixture.

Marshall Quotient (*MQ)*

The value of the marshall quotient is influenced by the quotient between corrected stability and the melting value. This quotient value is used as an approximation to the degree of stiffness or flexibility of a mixture. The greater the yield value for the marshall, the more rigid a mixture will be. The smaller the yield value for the marshall, the more flexible the mixture will be. From the test results in can be values as shown below:

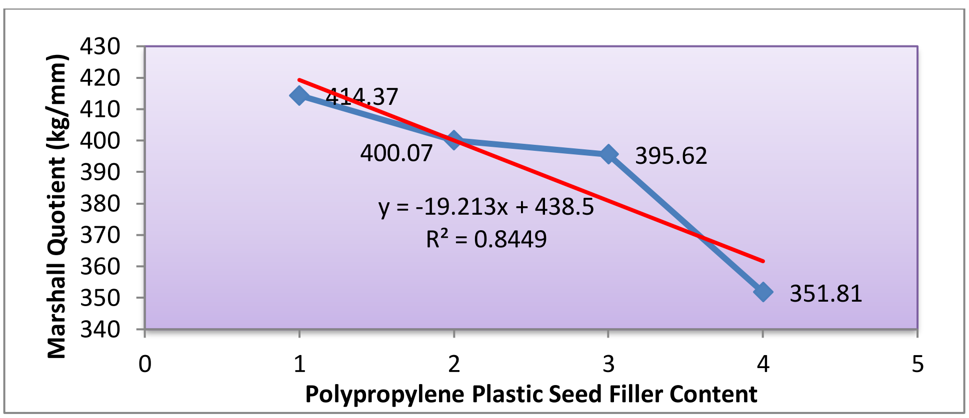

Figure 8 Comparison graph of yield quotient of *AC BC marshalls* with variations of *Polypropylene* Plastic Pellet *filler*

From figure 8 it can be seen that the overall *MQ value of the* Polypropylene *plastic pellet filler experiment* still shows values that meet the requirements of the 2018 revision 2 > 250 kg / mm specifications both without *filler* and with 1 %, 2% and 3% *filers*. The *MQ value* without *filler is 414.37 kg/mm, the value for 1% is 400.07 kg/mm, the value* *for 2% is 395.62 kg/mm and the value for 3% is 351.81 kg/mm, from the existing values, it is concluded that for the best flexibility in 3%* filler *in the AC BC mixture.*

The regression model in figure 8 is a simple linear regression for the stability value in the *AC BC mixture with the equation Y = -19.21x + 438.5 from this equation it can be seen that the minus value in the regression coefficient shows the number of bound variables (Y) based on the independent variable (X)* [20]*, meaning that if the addition of* Polypropylene Plastic Pellet filler *increases, it will cause a decrease in* the *MQ* value AC BC. For the value of R2 = 0.884, it shows that the effect of adding *Polypropylene* plastic pellet filler has an effect of 88.40% decrease in *the MQ* AC BC value..

CONCLUSION

From the test results, it can be concluded that the characteristics of the marshall test are the weight of AC BC content *without filler 2.289 gr/cc3, with 3% filler* of 2.300 gr/cc3, *VMA value* without filler *16.58%* with 3% filler of 15.30%, *VIM* value without filler 4.52%, with *filler* 3 % of 3.69%, *VFA* value *without* 73.58% *filler with 3% filler of 76.02%, stability* value without filler 1355 *kg, with 3% filler of 988.60* kg, flow *value without filler 3.27* mm with 3% filler of 2.81 mm, MQ *value without* filler 414.37 *kg/mm with 3% filler of 351.81 kg/mm.*

BIBLIOGRAPHY

Firdaus, Angga Pirman. "PENGARUH PENGGUNAAN LIMBAH PLASTIK POLYPROPYLENE (PP) SEBAGAI CAMPURAN AGREGAT KASAR TERHADAP KUAT TEKAN DAN TARIK PADA BETON FC'25 MPA." *Jurnal Infrastruktur* 3, no. 2 (2017): 81–89.

Jaya, Nyoman Martha, AAGA Yana, and IWGE Triswandana. "Penerapan Rekayasa Nilai Pada Proyek Pembangunan Gedung Sekolah (Studi Kasus Pembangunan Gedung Sekolah Sanur Independent School)." *Jurnal Spektran* 7, no. 1 (2019): 244–53.

Muhammad, Hamid, and D Ph. *Direktorat Pembinaan Sekolah Menengah Kejuruan Direktorat Jenderal Pendidikan Dasar Dan Menengah Kementerian Pendidikan Dan Kebudayaan Republik Indonesia*, n.d.

Mulyadi, A. "A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture." In *IOP Conference Series: Materials Science and Engineering*,

[20] Mulyadi, "A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture."

209:12088. IOP Publishing, 2017.

Nahak, Philipus Resato, Yosef Cahyo, and Sigit Winarto. “Studi Perencanaan Tebal Perkerasan Konstruksi Jalan Raya (Menggunakan Metode Bina Marga) Pada Ruas Jalan Umasukaer Di Kabupaten Malaka.” *Jurnal Manajemen Teknologi & Teknik Sipil* 2, no. 1 (2019): 75–85.

Nurdiana, Asri. “Analisis Biaya Tidak Langsung Pada Proyek Pembangunan Best Western Star Hotel & Star Apartement Semarang.” *Teknik* 36, no. 2 (2015): 105–9.

Sukirman, Silvia. “Perkerasan Lentur Jalan Raya,” 1999.

Sulistyaningsih, Ainaya, Andi Ainun Zuqny Nurin RA, Anik Kustirini, and Bambang Purnijanto. “KARAKTERISTIK MARSHALL TERHADAP PENGGUNAAN ASBUTON BUTIR B5/20 DENGAN SUBSTITUSI DASPAL DAN ASPAL PENETRASI 60/70.” *Bangun Rekaprima: Majalah Ilmiah Pengembangan Rekayasa, Sosial Dan Humaniora* 8, no. 2, Oktober (2022): 51–58.

Umum, Departemen Pekerjaan. “Direktorat Jenderal Bina Marga, 1997.” *Manual Kapasitas Jalan*, 1987.

Umum, Departemen Pekerjaan, and Perumahan Rakyat. “Direktorat Jenderal Bina Marga.” *Pengaspalan, Badan Penerbit Pekerjaan Umum*, 1997.

Umum, Kementerian Pekerjaan. “Peraturan Menteri Pekerjaan Umum Nomor 13 Tahun 2011 Tentang Tata Cara Pemeliharaan Dan Penilikan Jalan.” *Jakarta: Kementerian Pekerjaan Umum*, 2011.