IOP Conf. Series: Materials Science and Engineering **204** (2017) 012022 doi:10.1088/1757-899X/204/1/012022

The use of natural sand from lampusatu beach, kabupatenmerauke, papua for mixed asphalt concrete

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Abstract. The natural sand from LampuSatu Beach, KabupatenMerauke, Papua, is often used as building material by local people. This research aims to test the use of this natural sand for mixed asphalt concrete. Asphalt Concrete Wearing Course (AC-WC) with bitumen penetration 60/70 and variations of asphalt content 5%, 6%, 7%, 8% and 9% are used in this research. Testing result shows the stability 1372.17 kg, VIM 3.95%, VMA 16.81%, Flow 4.14 mm, and MQ 332.89 kg/mm. It has fulfilled the standard requirements set by Indonesian Director General for Highways. The percentage of Optimum Asphalt Content (OAC) is 7% and the Index of Retained Strength (IRS) is 107.84% (≥ 75%). These indicate that the mixture can fulfill the Stability and Marshall Immersion Test.

1. Introduction

There are three types of asphalt concrete based on its function, namely asphalt concrete as wear layers, binder layer and base course. The material of mixed asphalt concrete consists of aggregate, filler and bitumen. Filler usually consists of fly-ash serving as a binding gap for both material and air in the mix. This can increase the mass density of the mixture. The total amount for the use of filler in asphalt mixture is at least 1% of the total weight aggregate. The gradation of combined aggregate for mixed asphalt concrete layer must fulfill the limits and should be outside the "restriction zone" in accordance with the provisions of Indonesian Director General for Highways. In Indonesia it is typically to use hard to moderate asphalt penetration 60/70 and 80/100. The performance of asphalt concrete can be determined through Marshall Test (Marshall Characteristics). Marshall Test consists of some parameters, such as stability and melting (flow), Void In Mix (VIM), the levels of the cavity filled with asphalt (Voids Filled Asphalt, VFA), cavities in the aggregate (Voids In Mineral Aggregate, VMA), Marshall Quotient (MQ), and Compacted Aggregate Density (CAD). Marshall Test activities include: a) preparation of the specimen, b) determining the mass density of the specimen, c) checking the value of stability and flow, and d) the calculation of volumetric properties of the mixture.

The development of road construction at KabupatenMerauke, Papua, as one of the provinces in Indonesia, requires a very enormous expense because the pavement material should be brought from outside. There is not enough adequate resources at KabupatenMerauke. The natural sand from LampuSatu Beach, KabupatenMerauke, Papua, is often used as the building material by local people. However it has the hidden potential to be used as fine aggregate for mixed asphalt concrete. The natural sand materials from various places have been commonly tested and used as fine aggregate for

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mixed asphalt concrete. The use of natural sand from the local place can reduce the expenses needed for road construction.

Previous researches show that the natural sand from Central Kalimantan [1], natural sand from Gorontalo [2], natural sand from Podi River, Palu [3], natural sand from Kampar [4], natural sand from Bakau Beach, Seruyan city, Central Kalimantan [5] and natural sand from Kampar River, West Sumatra (Alfian, 2015) have fulfilled the requirements to be used as fine aggregate in mixed asphalt concrete, specifically for AC-WC. Therefore this research is conducted to test on the possibility of using natural sand from Lampu Satu Beach, Kabupaten Merauke, Papua. Asphalt Concrete Wearing Course (AC-WC) with bitumen penetration 60/70 is used in this research. The variations of bitumen content used are 5%, 6%, 7%, 8% and 9%. The characteristic of the natural sand from Lampu Satu Beach as fine aggregate is tested based on Marshall Test. The results of this research is expected to be the source of information for stakeholders of road construction in Papua, especially in terms of using natural material as an aggregate for mixed asphalt concrete, as well as being a reference for designing the mixture of AC-WC by using the natural sand from Lampu Satu Beach as fine aggregate.

2. Literature review

The minimum thickness of base layer (AC-Base) is 7.5 cm with a maximum aggregate size of 37.5 mm [6]. The hot mix asphalt concrete must fulfill some certain conditions to meet the criteria for specific traffic conditions [7]. It must be able to withstand long-term deformation and cracking due to fatigue loading, easy to implement, satisfactory compacted, water-proof, abrasion resistant due to the effect of traffic, air and water, contributed to the strength of pavement structure, easy to maintain, and most importantly, economical.

The performance of mixed asphalt concrete is dependent to the characteristics of the used aggregate, such as porosity, gradation and size distribution, absorption, shape and surface texture, rupture strength, modulus of elasticity, and the presence of substances that can damage the mixture [8]. Aggregate can be classified based on its volume density, origin size and mass density [9]. It is classified as sand-gravel (1520-1680 kg/m^3), light-weight aggregates (<1.120 kg/m^3) and heavy-weight aggregate (> 2.080 kg/m^3) based on its mass density. The aggregates are classified into: coarse aggregate (retained sieve number 4), fine aggregate (through sieve number 4) and filler (≥ 75% by weight through sieve number 200) based on its origin size. Fraction of coarse aggregate for asphalt mixture has a grain retained on the sieve number 8 (2.36 mm) through wet sieving, clean, hard, durable, and free from clay. The selection of the type of asphalt depends on the type of construction and the climate of a region. Asphalt texture will be hard and brittle at low temperatures and become soft at high temperatures [10]. The amount of bitumen content in pavement mixture ranges from 4-10% by weight of the mixture, or 10-15% of the volume of the mixture [11]. The asphalt classification is based on the value of penetration bitumen at a temperature of 25^{0}C, which is ranged from 4^0 to 30^0.

3. Methodology

Coarse aggregates were taken from Bili-Bili, South Sulawesi. Fine aggregates were taken from LampuSatu Beach, KabupatenMerauke, Papua. Asphalt binder was obtained from the Laboratory for Testing Road and Bridge Material at Indonesian Director General for Highways, South Sulawesi. Tonasa Cement was used as filler and taken from South Sulawesi.

The testing of AC-WC includes Void in Mix (VIM), stability, flow, Marshall Quotient (MQ) and Void in Mineral Aggregate (VMA). The Marshall Test was initially performed to predict the optimum asphalt content. Then, the specimen was prepared based on the predicted optimum asphalt content. Three specimens with the asphalt content higher than the optimum value and two specimens with asphalt content lower than the optimum value were also made with having each different value 0.5%. Three specimens were made for each asphalt content. The standard size for specimen used in testing was 63.5 mm (2.5 in). The adjustment for each the mixing temperature and compaction process were performed when the asphalt viscosity value reached about 170 ± 20 centistokes and 280 ± 30 centistokes, respectively.Compaction process was performed by applying 2 x 75 blows using Marshall compacting hammer. Then the specimen was kept in room temperature for 24 hours. Finally, the specimen was measured and weighed in air and water. The specimen was also measured in saturated

surface dry condition. Then, they were allowed to cure at temperature 600C for 30 minutes and ready to test. The testing parameters were stability value, flow value, MQ, VIM and VMA. The optimum asphalt content (i.e. the asphalt content that reaches all design criteria for AC-WC) could be determined. In this research, the optimum asphalt content was then called the Optimum Asphalt Content (OAC).

4. Results and discussion

4.1 Material characteristic and Marshall test result

The characteristic of fine and coarse aggregates were tested. These included the gradation and inspection of physical properties. The testing result is shown in table 1. Testing results indicate that both fine and coarse aggregate used for mixed asphalt concrete AC-WC has fulfilled and met the specification requirements of Indonesian Director General of Highways (2010).The asphalt content used in AC-WC mixture was the Optimum Asphalt Content (OAC) which has reached all design criteria according to the standard Marshall parameter 7.0% (figure 1). Marshall Test result that illustrates the value of VIM, stability, flow, MQ and VMA is shown in Table 1. The graph results are illustrated in figure 2. The testing result shows that the VIM values had been decreasing along with the increasing of asphalt content which is varied from 5.0% to 9.0%. The increasing of asphalt content could make the voids between the aggregate particles in the mix more and more filled with asphalt so that the value of VIM would increase.

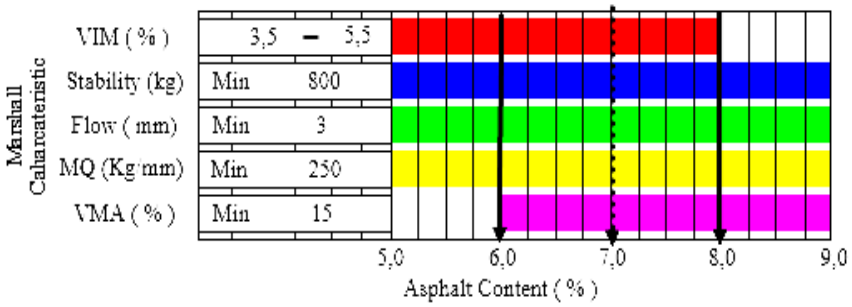


Figure 1. OAC analysis diagram of asphalt concrete mixtures AC-WC

Table 1. Marshall characteristic of asphaltconcrete

% asphalt	VIM	Stability	Flow	MQ	VMA
5,0	4,94	907,97	3,25	303,55	13,79
6,0	4,17	1239,32	3,68	349,27	15,07
7,0	3,95	1372,17	4,14	332,89	16,81
8,0	3,84	1659,74	4,26	397,29	18,61
9,0	3,34	1670,30	5,31	331,52	20,04

Stability test indicates that the stability value increases along with the asphalt addition, as more and more asphalt was used, the amount of asphalt that surrounds the aggregate would be growing. Therefore the asphalt covers that was created can be a good binder for aggregate to increase its stability. The flow value shows that the increasing of bitumen in the asphalt aggregate mixture can make the asphalt cover become thicker. Therefore it would increase the flow value as a function of the asphalt is for flexibility.The MQ results indicate that the asphalt content would decrease on 7.0%, increase on 8.0% and decrease back on 9.0%. However, the values of MQ entirely still fulfill the standard of Indonesian Director General of Highways.The standard value of MQ for heavy traffic

should be at least 250 kg/mm. It can be deduced that the increasing of MQ affects both the increasing of stability and decreasing of the flow. Otherwise the decreasing of MQ cause the decreasing of stability and increasing of the flow. The VMA value increases with the increasing of the asphalt content in the mixture. The increasing of asphalt content whose function is to fill cavities in the aggregate can filled the void within asphalt. Therefore the VMA value would be increasing.

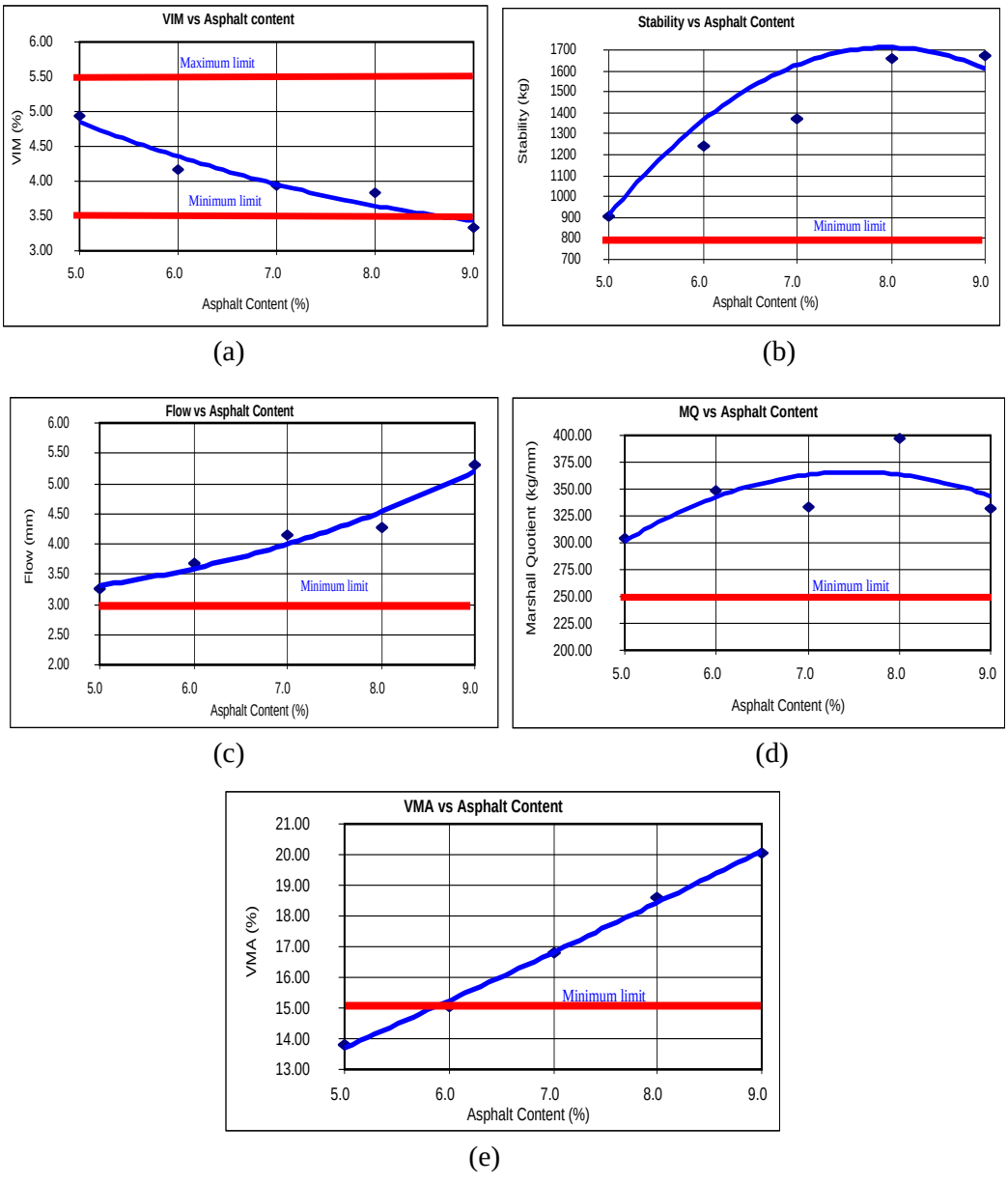


Figure 2. Marshall test result

4.2 Marshall immersion test result

The Index of Retained Strength (IRS) obtained from Marshall Immersion Test is 107.84%. This IRS value has fulfilled all the standard criteria (≥ 75%) specified by Indonesian Director General of Highways (2010). This indicates that the pavement using natural sand from LampuSatu Beach, Merauke, Papua with asphalt content of 7.0% has the resistance of temperature and water immersion, during the service time. This natural sand could not absorb the water in large amount. Hence even though the pavement is immersed in the water, the amount of water could not be absorbed directly into

the pavement. The resistance and durability of the pavement can be maintained if it has the proper, routine and periodic maintenance.

5. Conclusion

There are some conclusions that can be gathered from the data analysis. The testing results of natural sand from LampuSatu Beach, KabupatenMerauke, Papua, indicates that its characteristics has fulfilled the standard set by Indonesian Director General of Highways. Therefore it can be used as fine aggregate in road pavement.The percentage of Optimum Bitumen Content (OBC) which can be used to mix the asphalt concrete using the natural sand from Lampu Satu Beach as fine aggregate is varied from 6.0% to 9.0%. To optimize the mixing process, the midpoint values of OBC should be taken as 7%.The Index of Retained Strength (IRS) (107.84% ≥ 75%) indicates that the mixture can provide the stability and also fulfill the Marshall Immersion Test value. The mixture using natural sand from Lampu Satu Beach as fine aggregate has the resistance to the temperature changing, climate, or even when fully immersed in water.

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