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An analysis of characteristic of Asphalt Pen 60/70 mixed with gilsonite additive

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Abstract. The increase of the population growth in Indonesia causes an increase of the traffic volume on the road. With the increase of the traffic volume, it is necessary to improve the quality of the road construction, especially from the pavement layer quality. On the road that have moderate traffic volume to high traffic volume, several problems in the pavement layer are often found. One way to decrease the road damage is by improving the quality of the asphalt mixture, which means increasing the asphalt quality. The research design is conducted by testing the characteristic of Asphalt Pen 60/70 and also the Asphalt Pen 60/70 mixed with gilsonite additive at 4.5%; 5.5%; 6.5%; 7.5%; and 8.5% of the asphalt weight. The Asphalt Pen 60/70 mixed with the gilsonite additive is called as the modified asphalt. Based on the testing results, it is obtained that the characteristic of modified asphalt has a better asphalt characteristic than the Asphalt Pen 60/70. The percentage of gilsonite level that still meets all the modified asphalt requirements is at the percentage of 6.5% with ductility value >140 cm, 336ºC flash point, 54.5ºC softening point, 1.037 gravity specific, and 41 penetrations. Besides, the 7.5% and 8.5% gilsonite levels have better asphalt characteristic than the Asphalt Pen 60/70.

1. Introduction

There is an increase of the population growth every year in Indonesia. Moreover, there is also an increase in the population mobility, resulting an increase in the traffic volume on the road. With the increase of traffic volume, it is necessary to improve the quality of the road construction, especially the quality of the pavement layer to meet the people needs. On the roads that have moderate traffic volume to high traffic volume, a damage of pavement layer is often found such as cracks, wheel track traces, and a rises of asphalt to the surface.

One way to reduce the road damage is by increasing the quality of asphalt mixture. It can be done by increasing the quality of the asphalt [1].

Asphalt itself is a binder which has an important role in determining whether or not an asphalt mixture is strong. One thing that can be done in increasing the quality of asphalt is by providing an additive to the asphalt. Therefore, this research is conducted in laboratory to find out the impact of the gilsonite addition to the asphalt, which is expected can increase the quality of asphalt. The asphalt that is added by gilsonite can be called as a modified asphalt gilsonite.

2. Research method

The research design is conducted by testing the characteristic of pertamina asphalt with 60/70 penetration and also the asphalt with the addition of gilsonite with 4.5%; 5.5%; 6.5%; 7.5%, and 8.5% levels of asphalt weight. Gilsonite is one of the higher purity natural asphalts and has a low fixed carbon low sulfur content. Rondon and Reyes used this material to produce an asphalt concrete mixture and evaluated its properties under monotonic and dynamic loading. The results obtained from their study demonstrated that the asphalt mixtures modified with Gilsonite using a wet process, i.e., adding Gilsonite to the asphalt cement, generated stiffer asphalt concrete mixtures, leading to the conclusion that these mixtures would perform well in warm climates(2). The additive (Gilsonite) which is used in this study can be seen in Figure 1.

Figure 1. Gilsonite before and after milling [2].

Table 1. The specification of the Asphalt test material characteristic that is used in the research [3].

No	Type of Testing	Type I Asphalt Pen 60/70	Type II Modified Asphalt Synthethic Elastomer
1	Penetration at 25°C (0.1mm)	60-70	Minimum 40
2	Softening Point (°C)	≥48	≥54
3	Ductility at 25°C(cm)	≥100	≥100
4	Flash Point (°C)	≥232	≥232
5	Density	≥1.0	≥1.0

The Specification for the characteristics of Asphalt Pen 60/70 and Asphalt Modification used in this study can be seen in table 1.

3. Results and discussion

3.1. The characteristic testing of Asphalt Pen 60/70

Table 2. The characteristic of Asphalt Pen 60/70.

Characteristic	Result	Specification [3]	Information
Penetration	63	60-70	Full filed
Viscosity (cST)	360	≥ 300	Full filed
Softening Point (˚C)	51.1	≥ 48	Full filed
Density	1.033	≥ 1.0	Full filed
Ductility (Cm)	>140	≥ 100	Full filed

Based on table 2 It can be seen that the Asphalt Pen 60/70 that is used in this study has met the specification requirements of Bina Marga Third Revision of 2010 as an asphalt mixture.

3.2. The analysis of Asphalt Pen 60/70 with modified asphalt gilsonite characteristic

3.2.1. Penetration. The result of penetration test will indicate the capability of binder in resisting the permanent deformation due to temperature changes [4].

Table 3. The result of asphalt penetration testing.

Material	Penetration Value	Requirements	Information
Asphalt + 0 % Gilsonite	63	60-70	Full filed
Asphalt + 4.5% Gilsonite	46	Minimum 40	Full filed
Asphalt +5.5% Gilsonite	43	Minimum 40	Full filed
Asphalt + 6.5% Gilsonite	41	Minimum 40	Full filed
Asphalt + 7.5% Gilsonite	38	Minimum 40	Not Fulfilled
Asphalt + 8.5% Gilsonite	33	Minimum 40	Not Fulfilled

Based on table 3 it can be seen that there is a decrease in penetration value as gilsonite levels are added. The lowest penetration value is obtained on the condition of asphalt with 8.5% gilsonite mixture which is 33.

The results of the penetration value of Asphalt Pen 60/70 meet the requirements for hard asphalt, which is a minimum of 60. Meanwhile, for the asphalt with gilsonite mixture, it can be classified as modified elastomeric asphalt with the penetration value requirement is 40. Therefore, the asphalt with 7.5% and 8.5% gilsonite mixture already does not meet the requirements.

Based on the results of penetration value, it can be concluded that the higher level of gilsonite, the penetration value of asphalt will decrease further. The asphalt that has low penetration value will make the characteristic of asphalt become harder. It shows that the asphalt with higher percentage of gilsonite has harder asphalt characteristic. Then, the harder the asphalt, the lower the deformation and rutting values.

3.2.2. Softening point. Softening point is the amount of temperature where the asphalt reaches its softness or melts degree [5].

Table 4. The result of Asphalt softening point testing.

Material	Softening Point Value(ºC)	Requirements (ºC)	Information
Asphalt + 0 % Gilsonite	51.1	≥ 48	Fulfilled
Asphalt + 4.5 % Gilsonite	52.5	≥ 54	Not Fulfilled
Asphalt +5.5 % Gilsonite	53.4	≥ 54	Not Fulfilled
Asphalt + 6.5 % Gilsonite	54.5	≥ 54	Full filed
Asphalt + 7.5 % Gilsonite	55.8	≥ 54	Full filed
Asphalt + 8.5 % Gilsonite	56.9	≥ 54	Full filed

It can be seen from Table 4 that the higher gilsonite level of asphalt, the higher the softening point will be obtained. In this study, the Asphalt Pen 60/70 has a softening point temperature of 51.1 ºC. According to the general specification of Bina Marga Third Revision of 2010, this temperature meets the specification of softening point temperature of Asphalt Pen 60/70 which is ≥48 ºC. The modified asphalt with elastomer has a minimum requirement of softening point temperature with 54 ºC. Therefore, the asphalt with 4.5% and 5.5% level of gilsonite does not meet the requirements. It indicates that gilsonite in asphalt can reduce the sensitivity of asphalt to the temperature, thus the high softening point is very suitable for the tropical country.

3.2.3. Flash point. The flash point testing aims to find out the maximum heating temperature of asphalt where it is still within the safe limits on its implementation (workability), and the characteristic of asphalt do not change because of the excessive heating [5].

Table 5. The result of asphalt flash point testing.

Material	Flash Point Value (°C)	Requirements (°C)	Information
Asphalt + 0 % Gilsonite	330	≥232	Full filed
Asphalt + 4.5% Gilsonite	332	≥232	Full filed
Asphalt +5.5 % Gilsonite	334	≥232	Full filed
Asphalt + 6.5 % Gilsonite	336	≥232	Full filed
Asphalt + 7.5 % Gilsonite	338	≥232	Full filed
Asphalt + 8.5 % Gilsonite	340	≥232	Full filed

Table 5 show that the optimum flash point value with the addition of gilsonite on asphalt is reaching 340°C. The flash point value obtained has already meet the requirements, which is ≥232 °C.

3.2.4. Ductility. Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking [6].

Table 6. The result of Asphalt ductility testing.

Material	Ductility Value (cm)	Requirements (cm)	Information
Asphalt + 0 % Gilsonite	>140	≥ 100	Full filed
Asphalt + 4.5 % Gilsonite	>140	≥ 100	Full filed
Asphalt +5.5 % Gilsonite	>140	≥ 100	Full filed
Asphalt + 6.5 % Gilsonite	>140	≥ 100	Full filed
Asphalt + 7.5 % Gilsonite	>140	≥ 100	Full filed
Asphalt + 8.5 % Gilsonite	132.5	≥ 100	Full filed

From the ductility test results, the ductility value of 60/70 pen asphalt and asphalt with the addition of gilsonite still meet the requirements, which is ≥ 100. However, there is a decrease in ductility value in the addition of 8.5% gilsonite as much as 7.5 cm.

The decreasing of ductility value shows that if gilsonite is added more than 8.5%, then the modified asphalt gilsonite will be stiff and brittle.

Mixed ductility also affects the strength of asphalt in binding the aggregate of the test object. In this study, the ductility value is stable with an increase level of gilsonite. Thus, it indicates that asphalt and gilsonite have good binding capacity to aggregate.

3.2.5. Specific Gravity. In essence, the specific gravity measurements are conversion factors which allows conversion of mass percentages to volume proportions/percentages [7].

Table 7. The result of asphalt density testing.

Material	Density Value	Requirements	Information
Asphalt + 0 % Gilsonite	1.033	≥ 1.0	Full filed
Asphalt + 4.5 % Gilsonite	1.035	≥ 1.0	Full filed
Asphalt +5.5 % Gilsonite	1.036	≥ 1.0	Full filed
Asphalt + 6.5 % Gilsonite	1.037	≥ 1.0	Full filed
Asphalt + 7.5 % Gilsonite	1.038	≥ 1.0	Full filed
Asphalt + 8.5 % Gilsonite	1.041	≥ 1.0	Full filed

A specific gravity testing is required for the planning design of asphalt and aggregate mixture. Based on the general specification of Bina Marga Third Revision of 2010, the density of asphalt is required ≥1.00. Table 7 shows that the density of asphalt without gilsonite has the lowest value compared to gilsonite mixed asphalt. Density will increase when gilsonite level is added. The addition of this density does not occur significantly, which is 0.008. Overall, the density for all types of asphalt has met the general specification of Bina Marga Third Revision of 2010.

3.2.6. Mixing temperature and compaction temperature. Mixing temperature and compaction temperature for the making of the test object are determined based on the viscosity value/asphalt viscosity.

Table 8. Mixing temperature and compaction temperature.

Material	Mixing Temperature (°C)	Compaction Temperature (°C)
Asphalt + 0 % Gilsonite	151-157	139-144
Asphalt + 4.5 % Gilsonite	155-160	144-149
Asphalt +5.5 % Gilsonite	158-163	146-151
Asphalt + 6.5 % Gilsonite	160-165	149-154
Asphalt + 7.5 % Gilsonite	162-168	150-155
Asphalt + 8.5 % Gilsonite	165-171	153-158

Based on table 8 it can be concluded that the mixing temperature and compaction temperature with the increase of gilsonite level have increased. This change will affect the process of test object making. Regardless of the selected procedure, recommend that laboratory mixing temperatures do not exceed 177 °C (350 °F). Compaction temperature usually in the range of 135-155°C (275-310°F) [8].

4. Conclusions and suggestions

4.1. Conclusions

Based on the result of the study on the characteristics of modified asphalt with gilsonite that has been conducted, it can be concluded as follows:

4.1.1. The characteristic result of the gilsonite modified asphalt with 60/70 penetration asphalt mixture are:

- The softening point value of the modified asphalt tend to increase along with the addition of gilsonite level. The softening point value in the addition of 4.5% and 5.5% gilsonite do not meet the requirements with each value of 52.5^{o}C and 53.4 ^{o}C.
- The ductility value of the modified asphalt is stable along with the addition of gilsonite level, and there is a decrease of ductility value on the addition of 8.5% gilsonite.
- The penetration value of the modified asphalt tends to decrease along with an increase in gilsonite level.
- The flash point of the modified asphalt has an increase along with an addition of gilsonite level.
- The density of the modified asphalt is increasing along with the addition of gilsonite.

4.1.2. The percentage of gilsonite level that still meet all the modified asphalt requirements is 6.5% with ductility value >140 cm, 336^{o}C flash point, 54.5^{o}C softening point, 1.037 material density, and 41 penetrations. Besides, 7.5% and 8.5% level of gilsonite also have better characteristic of asphalt than 60/70 pen asphalt.

4.1.3. Theoretically predicted, the characteristic of asphalt with 6.5%, 7.5%, and 8.5% level of gilsonite show that modified asphalt with that level have better characteristic than 60/70 pen, so it can increase the quality of asphalt mixture.

4.2. Suggestions

There are several suggestions for further studies:

- It is expected for further studies to use other additive.

- A future research is suggested to conduct other test with 6.5%, 7.5%, and 8.5% level of gilsonite as the making of test objet for Marshall testing, wheel tracking, or umatta testing.

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