Wear Rate by Utilizing Asphalt Starbit PG 70 Due to Peat Water Soat

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A R T I C L E I N F O	A B S T R A C T
  IEEE Style in citing this article : *K. B. Simbolon, M. Anggraini dan A. Saleh, "Wear Rate by Utilizing Asphalt Starbit PG 70 Due to Peat Water Soat,"* CIVILA, *vol. 8, no. 1, pp. 93-102, 2023.*	Asphalt Starbit PG 70 is a polymer (elastomer) based modified asphalt. The advantages of Asphalt Starbit PG 70 are resistant to water and weather, thus affecting the construction of highway infrastructure. Construction of highways in peat water areas, where the characteristics of peat water are that it contains high levels of organic matter and iron and has a low pH $< 4 - 5$, causing performance disturbances and causing pavement damage. The study aimed to analyze the wear value of Starbit asphalt due to peat water immersion for 30 minutes, 24 hours, and 48 hours. The research method is wear testing based on the 2018 Revision 2 Bina Marga Specifications. The results of soaking in peat water for 48 hours experienced an increase in weight loss of 7.37% due to having a high level of acidity which contains lignin compounds in organic matter. Meets the specifications of Highways 2018 Revision 2, namely for a weight loss value of $\leq 20\%$.

1.   Introduction

Asphalt is an aggregate binder in road pavement construction which plays an important role in determining pavement performance even though its composition is 4-10% based on the total weight of the mixture [1]. As a thermoplastic material, asphalt will melt if heated to a certain temperature and re-freeze if the temperature drops [2]. The need for asphalt in Indonesia is increasing from year to year in line with economic growth, which requires the support of reliable infrastructure in road construction so. The demand for asphalt as a construction material is around 1.3 million tons per year, which is only fulfilled by national asphalt at around 344 tons per year. PT Pertamina (Persero) only fulfils 30% [3]**.** Asphalt polymer is a material that results from modifications between natural polymers and asphalt. Modifying asphalt polymer obtained from the interaction between asphalt components and polymer additives can improve the properties of the asphalt [4]. Modified asphalt can improve the service performance of road pavements to produce a mix with good stability [5]. One type of modified asphalt that already has a manufacturer is Starbit PG 70 asphalt. Starbit PG 70 asphalt was developed by PT. Bintang Djaja includes polymer-based (elastomer) modified asphalt in which commercial

asphalt products are added with additives and manufactured according to the new Bina Marga specifications requirements. The strength of asphalt as an aggregate adhesive will be disturbed by water entering into the cracks of the asphalt concrete mixture [6]. Damage to road construction is caused by temperature, water, and pavement construction that does not meet construction requirements [7]. Stagnant water can cause road damage because water can loosen the bond between aggregate and asphalt so that when passing vehicles pass, it will put a load that causes cracks or other road damage [8]. Riau Province has peatlands reaching 3,867,414 ha with a percentage of 60.1% of the area of peatland on the island of Sumatra, almost 3⁄4 of the total area of the Riau region with a flexible pavement type of 1.3 km [9]. Where the construction of roads on soft soils is often found in flexible pavements on peat soils, where peat water stagnation causes the pavement layer's resistance to friction of vehicle wheels against peat water areas to wear out. This study used modified asphalt, namely Starbit asphalt, to see the wear value due to peat water immersion. Wear studies for Starbit asphalt with variations in peat water immersion have not been studied before. The purpose of the wear value is to determine the wear resistance of the road coating, where the percentage of weight loss on the test object in the 2018 Highways revision 2 is ≤ 20%. The wear test describes how much strength the road coating has to withstand the occurrence of friction between the rollers of each vehicle and the road surface [10]. The review in this study is the surface layer (AC-WC) of Bina Marga specifications, where this surface layer is in direct contact with the wheels, so research is carried out on the wear value submerged by peat water using Starbit PG 70 asphalt. Immersion of the test object at the compaction temperature is equal to 60 ℃ and variations of immersion time used 30 minutes, 24 hours, and 48 hours. The addition of the duration of immersion time was carried out for 24 hours and 48 hours to determine the resistance of the pavement due to water, especially on peat water [11]. This situation can get worse if the road is flooded with water for more than 24 hours which is continuously burdened with the limited excessive weight of transportation [12]. The study aimed to analyze the wear value of Starbit asphalt due to immersion in peat water for 30 minutes, 24 hours, and 48 hours. The road pavement layer is composed of four layers, namely: - surface layer (wearing course), base course, subbase course, and subgrade [13]. One of them is the asphalt concrete wearing course (AC-WC) layer, which is the top surface layer of the highway pavement structure in direct contact with the vehicle wheels; it has a smoother texture and can continue the measured carrying capacity and can protect the structure underneath [14]. The road pavement-forming materials are asphalt, coarse aggregate, fine aggregate, and added material (filler) [15]. The asphalt used is modified asphalt (Starbit asphalt). Starbit asphalt is an elastomeric-based modified asphalt developed by PT. Bintang Jaya was launched in mid-2005 and processed to meet the requirements of Bina Marga specifications; it has the advantages of elastic recovery, aggregate adhesion, oxidation resistance, fatigue resistance, deformation resistance, and strength against water and weather [16]. Aggregates are natural aggregates, namely coarse aggregate and fine aggregate [17]. The Marshall Test is a testing technique to determine the feasibility level of the asphalt mixture in road design during construction [18]. So that immersion in peat water has a level of acidity (pH) which has a pH value ranging from 0-14, a neutral solution that is has a pH value = 7, an alkaline solution has a pH value > 7, and an acidic solution has a pH value < 7[19]. The acid content of peat soil is pH 4 − 5 which can be said to be acidic if the pH is < 7 which has a characteristic reddish-brown colour due to the high organic matter or dissolved humus in the form of humic acid [20].

2.   Research Method

The research was carried out at three locations, and the tests on sieve analysis and wear were carried out at the Civil Engineering Study Program Laboratory at Lancang Kuning University. The location of this research is shown in the following figure:

Source: Google Earth, 2022

Figure 1. Laboratory Research Locations

Penetration testing of 25℃ and softening point on Starbit PG 70 asphalt was conducted at the Civil Engineering Sekolah Tinggi Teknologi Pekanbaru Laboratory.
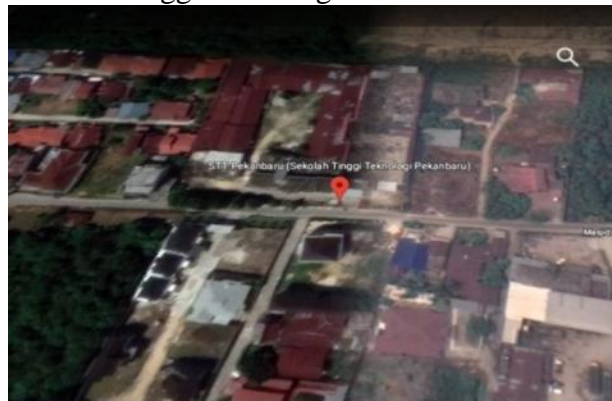
Source: Google Earth, 2022

Figure 2. Research Locations Sekolah Tinggi Teknologi Pekanbaru

Testing the pH of peat water was carried out in the Chemical Engineering Practicum Room, SMK Negeri 2 Pekanbaru.
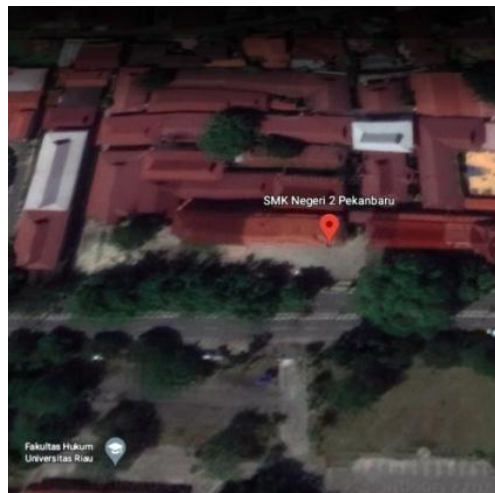
Source: Google Earth, 2022

Figure 3. Research Locations SMK Negeri 2 Kota Pekanbaru

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Description and Technical

1.   Population and Samples.
        The population and samples are used as follows:
        a.   Coarse Aggregate
             The coarse aggregate of this material comes from the Simpang Batu Bersurat area, obtained from PT. Hakaaston.
        b.   Fine Aggregate
             This material comes from the Simpang Batu Bersurat area, obtained from PT. Hakaaston.
        c.   *Filler*
        d.   Starbit Asphalt
             This asphalt is produced by PT Bintang Djaja.
        e.   Peat water
             Peat water is taken from the area of Jl. Jendral Sudirman Pekanbaru City with low pH < 4 - 5.

2.   Sampling Techniques.
        Sampling technique on modified asphalt, namely Starbit PG 70 asphalt, which was ordered directly from PT. Bintang Djaja already has a manufacturer, while aggregate sampling is taken directly from the quarry in the Simpang Batu Bersurat area at PT. Hakaaston, and sampling of peat water from the area of Jl. General Sudirman of Pekanbaru City.

3.   Definition of Variable Operations.
        Starbit PG 70 asphalt samples will be tested for specific gravity, penetration, and softening point, while coarse aggregate samples will be tested for sieving, specific gravity, and absorption of coarse aggregate, and wear and tear, and fine aggregate samples will be tested for sieving analysis, specific gravity and absorption, and an equivalent. In testing peat water, pH testing was carried out.

4.   Instrument Analysis Tool.
        In the instrument analysis tool, namely testing the properties of coarse aggregate, namely testing sieving analysis, specific gravity and absorption of coarse aggregate, and testing wear on coarse aggregate. In fine aggregate testing, namely sieve analysis, specific gravity and absorption, and sand equivalent testing. After testing on aggregate, testing on asphalt is specific gravity, penetration, and softening point. After obtaining the test data, the test specimens were made and tested on the Marshall test to obtain the optimum asphalt content value on Starbit PG 70 asphalt. Before soaking, it is necessary to do a pH test on peat water which refers to SNI 06-6989.11-2004. Samples that have been made are soaked in peat water with a water bath for 30 minutes, 24 hours, and 48 hours of immersion time. After immersion, a wear test is carried out on each sample to find the ratio of the weight value of the sample material after 300 rounds to the original weight before being loaded into the Los Angeles machine.

5.   Data Analysis
     The data obtained from laboratory test results were processed from the Marshall test results to obtain the optimum asphalt content value. Testing the PH of peat water on the water samples taken, after that, the asphalt mixture that has been printed is soaked using a water bath for 30 minutes, 24 hours, and 48 hours of immersion time. Analysis of wear test data refers to the 2018 Highways Specifications Revision 2.

3.   Results and Discussions

Check the properties of the aggregate:

3.1   Properties of the Coarse Aggregate

Table 1. Coarse aggregate inspection

No	Test Type	Requirement Score (Highways 2018 Revision 2)	Material Testing Results	Information
1	Los Angeles Engine Wear %	Maks 40 %	16 %	Fulfil
2	Aggregate Specific Gravity	≥ 2,5	2,703	Fulfil
3	Absorption of water by aggregates	<3	2,211	Fulfil

Source: Data analysis (2023)

Based on the results of the wear and tear examination of the coarse aggregate with the Los Angeles machine that was carried out, it yielded 16%, the results of the inspection of the specific gravity of the aggregates produced 2.703, the results of the inspection of water absorption by the aggregates produced 2.211.

3.2   Properties of the Fine Aggregate

Table 2. Inspection of fine aggregate

No	Test Type	Requirement Score (Highways 2018 Revision 2)	Material Testing Results	Information
1	Aggregate Specific Gravity	≥ 2,5	2, 662	Fulfil
2	Sand Equivalent	> 50	94, 1%	Fulfil
3	Absorption of water by aggregates	< 3	1, 626	Fulfil

Source: Data analysis (2023)

Based on the inspection, it was found that the specific gravity of the fine aggregates carried out was 2.662, the results of the Sand Equivalent examination carried out were produced 94.1, and the results of examining the absorption of water by the aggregates carried out were produced 1.626.

3.3   Asphalt Inspection

Asphalt inspection testing is as follows:

Table 3. Asphalt inspection

No	Test Type	Requirement Score (Highways 2018 Revision 2)	Material Testing Results	Information
1	Asphalt Specific Gravity	> 1,0	1, 022	Fulfil
2	Penetration	-	48,7	Fulfil
3	Soft Point	-	49,5 ℃	Fulfil

Source: Data analysis (2023)

In the inspection of asphalt properties, there is an examination of the specific gravity of start PG 70 asphalt; the specific gravity value is 1.022 gr, the asphalt penetration inspection value is 48.7, and the softening point examination of the test object is 49.5 ℃.

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4.4   pH check

The results of examining the pH of peat water using Universal paper with pH results obtained <4 – 5 show that peat water is classified as acidic.

4.5   Marshall inspection to find the optimum bitumen content

Finding the planned asphalt content (Pb) to determine the value (KAO), the calculation can be seen in the following equation:

Pb   = 0,035 (%CA) + 0,045 (%FA) + 0,18 (%MA) + K (1)
   = 0,035 (57,66) + 0,045 (36,36) + 0,18 (5,98) + 1
   = 2,018 + 1,636 + 1,0 + 1
   = 5,56 %

The results of the Marshall test are:

Table 4. Marshall Test Testing

%Asphalt	Density	VFWA	VITM	VMA	Stability	Flow	MQ
5,0	2,35	57,93	7,37	22,50	847,04	3,43	246,71
5,5	2,42	71,48	5,66	20,48	1436,78	3,63	395,44
6	2,42	82,02	4,53	19,70	1018,92	3,82	266,96
6,5	2,40	78,72	4,29	20,79	986,30	3,78	260,93
7	2,48	86,70	3,05	20,42	1134,25	4,48	252,99
7,5	2,44	89,30	2,27	21,18	582,69	4,60	126,67
Highways 2018 Revision 2	>65	3-5	>15	>800	2-4	>250	

Source: Data analysis (2023)

The determination used the narrow range method, namely taking the median value of the characteristics of the Marshall test results that meet the requirements for the Marshall characteristic value limit. The optimum asphalt content values are summarized in the following figure:
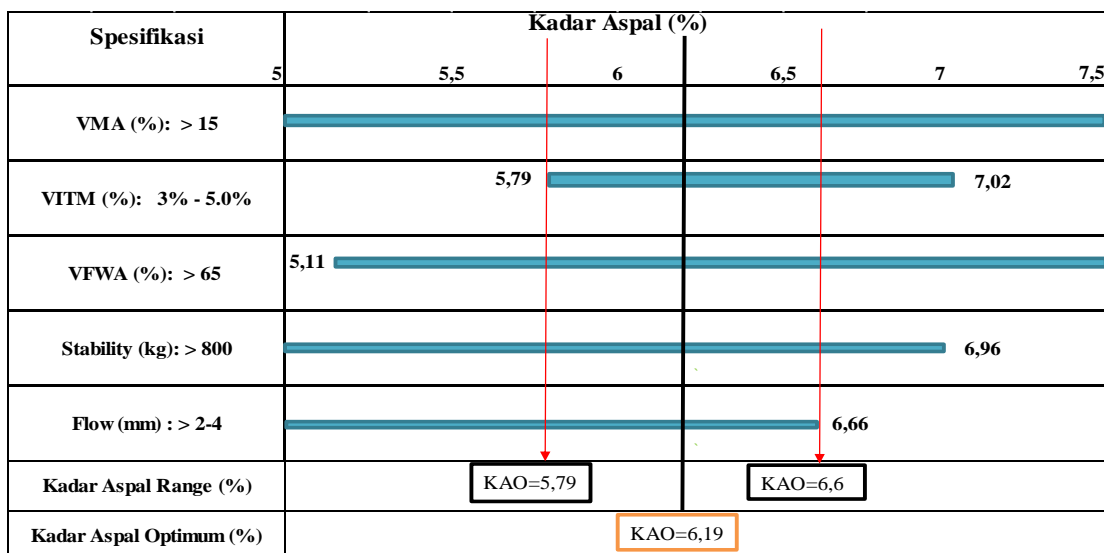

Figure 1. The optimum asphalt content values

The results of determining the optimum asphalt content using the narrow range method. So the percentage value of asphalt content ranges from 5.79% to 6.61%. The optimum asphalt content value is obtained by taking the median value of the range asphalt content resulting in an optimum asphalt content value of 6.19%.

4.6   Wear Check

Table 5. Typical Water Wear Test Results

Immersion Variation	Wear Value Requirements (Based on Highways 2018 Revision 2)	Wear Rate (%)	Information
30-minute variation		3,41	Fulfil
24-minute variation	≤ 20 %	3,79	Fulfil
48-minute variation		5,20	Fulfil

Source: Data analysis (2023)

From the results of the wear test examination from the table, the wear value in ordinary water immersion can be obtained in the wear value in 30-minute immersion after 300 revolutions of 3.41%, in 24-hour immersion after 300 processes of 3.79%, and in 48-hour immersion after 300 rotation is 5.20%, and in the specifications of Highways, Revision 2 meets the threshold value for wear value ≤ 20%.

Table 6. Table of Peat Water Wear Results

Immersion Variation	Wear Value Requirements (Based on Highways 2018 Revision 2)	Wear Rate (%)	Information
30-minute variation		3,68 %	Fulfil
24-minute variation	≤ 20 %	5,24 %	Fulfil
48-minute variation		6,82 %	Fulfil

Source: data analysis (2023)

From the results of the wear test examination from the table, the wear value in peat water immersion can be obtained in 30 minutes after 300 rounds at 3.68%, in 24-hour immersion after 300 rounds at 5.24%, and in 48-hour immersion after 300 rounds at is 6.82% and in the specifications of Highways Revision 2 already meets the threshold value of the requirement for wear value ≤ 20%.
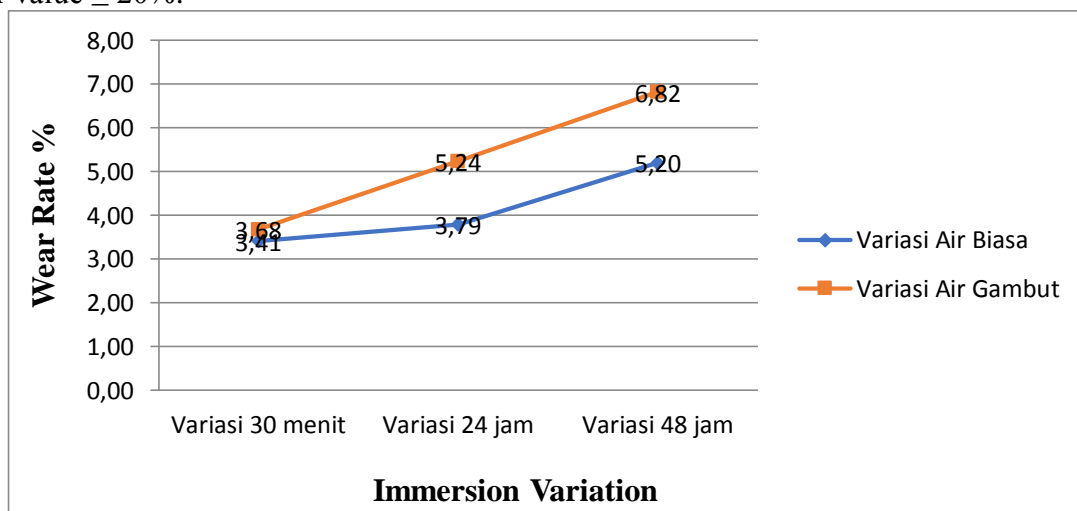

Figure 2. Graph of Wear Test Results

The effect of immersion in ordinary water and peat water in each immersion has increased. The wear percentage value at 300 rotations with 48 hours of immersion time in

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ordinary water is 5.20%, and peat water is 6.82%. The results meet the requirements of the 2018 Revision 2 Bina Marga specification with a threshold value of the wear value requirement ≤ 20%.

5. Conclusion and Suggestion
5.1   Conclusion

From the results of the study of the Wear Value by Utilizing Starbit PG 70 Asphalt As a Result of Peat Water Soaking, the wear value was obtained by using a Los Angeles machine for a long immersion time of 30 minutes, 24 hours, and 48 hours with peat water meeting the requirements for a wear value of ≤ 20%. Based on the results of the calculation of the weight loss value of the test object with peat water immersion time of 48 hours, the highest weight loss was 6.82%. The high wear value is caused by the acidity of the peat water by the organic matter contained in the peat water. Then the results of the wear and tear of the test object are included in the specifications for the 2018 Highways Revision ≤ 20%.

5.1   Suggestion

Based on the results of the research that has been done, the suggestions for this research are:
1. There needs to be workability using Asphalt Starbit PG 70 to test the wear value.
2. It is necessary to carry out chemical testing of Asphalt Starbit PG 70 and Peat Water.
3. It is necessary to take samples in the field and test the aging characteristics of roads in peat areas against the Cantabro test.

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