Design and Characterization of Renewable Bioasphalt Containing Damar Resin, Fly Ash, Wasted Cooking Oil and Latex

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Abstract. Dasphalt is one alternative of bioasphalt, made from materials that can be renewed as a substitute for conventional asphalt. Dasphalt inspired from *jabung* made of damar resin, brick powder and wasted cooking oil. Jabung have the same character with conventional asphalt. Research has been conducted by the characteristics of jabung but there are still many shortcomings, softening point and ductility values are not qualify. In this research the brick powder will be replaced by fly ash, as fly ash has a finer grain so that it can become a better absorbent. The resin will act as a natural resin for dasphalt, wasted cooking oil will be a mixed solvent. Use of additional polymers latex, is expected to improve the elasticity of dasphalt in ductility test. The purpose of this study was to determine the nature of the modification dasphalt properties in accordance with the specifications of asphalt penetration test and find the optimal composition of dasphalt. This research method is done by direct testing in the laboratory. In the present study that became the basic composition of the resin is resin (100g pure resin+ 350g resin packaging or powder), fly ash (150g) and wasted cooking oil (205g) and latex were mixed at temperatures below 150°C. While variations of latex starting from 0%, 2%, 4%, 6%, 8% and 10%. Several asphalt characterization are performed include penetration tests, test softening point, ductility test, flash point test, specific gravity test, affinity test and solubility test. Dasphalt modification achieved optimum composition of resin (100g pure resin or resin chunk + 350Gr packaging), Fly Ash powder (150g), cooking oil (205g), and latex 4%, ductility increased from 63.5 cm to 119.5 cm , the value of the flash point was originally at temperature of 240°C to 260°C, dasphalt penetration from 68.2 dmm to 43 dmm, and the value of density decreases to 1.01 g/cm^3 to 0.99 g/cm^3. Dasphalt modifications meet some of the specifications and could be categorized as bitumen penetration 40.

1. Introduction

Demand for asphalt as a pavement construction, whether for maintenance, rehabilitation or construction of road transport continues to increase along with the growth of the infrastructure construction. Asphalt required as materials for road pavement is very huge. Concerns arise as the depletion of oil reserves that are available today. As a result of oil prices tend to be more expensive. Thus requiring other alternative materials as a substitute for conventional asphalt such as asphalt derived from biomass or often called as bioasphalt.

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One alternative that was found as a basis in the previous research was jabung. Jabung or dasphalt (damar asphalt) used by silversmith in Yogyakarta as a cushion to carve out a silver ring. Composition of jabung or dasphalt used is damar resin, brick powder and cooking oil. Visually dasphalt resembling asphalt pavement in general are dark in color, elastic, having adhesion but has the advantage that is more water resistant.

Previous research by M F Nasution et al used the best composition of dasphalt namely damar 450g, brick powder 150g and wasted cooking oil 170g [1]. However, the results showed that the softening point and ductility test does not meet the requirements of bitumen penetration 60. To follow up on it, then further research on dasphalt by changing the composition of the mixture into a damar resin [2], fly ash, oil and latex. Changes in the use of brick powder material into fly ash powder is constituted by a shortage of bricks in terms of uniformity and grain size. Fly ash has smaller grains and more uniform than brick powder, so that fly ash has a surface area greater than brick powder. The surface area of the larger and more uniform size will do better binding dirt so it will purify a dasphalt mixture. The use of fly ash as an ingredient of dasphalt will be one of the waste management solutions considering this material is a hazardous waste if not handled properly. Fly ash also have a low economic value and readily available in large quantities [3].

The addition of a polymer latex is expected to improve the shortcomings of previous dasphalt composition in terms of softening point and ductility tests. As a polymer, latex is expexted to improve stiffness and elasticity, so dasphalt will prform better resistance to deformation and rutting [4].

2. Experimental

2.1 Materials

2.1.1 Asphalt

Asphalt is a material that is a solid at room temperature until slightly dense, and are thermoplastic. Thus, the asphalt will melt when heated to a certain temperature, and re-freezes when the temperature drops. Together with aggregates, asphalt is a mixture of pavement forming material.

2.1.2 Dasphalt

Dasphalt (Damar Asphalt) is a mixture of four components include a damar resin, fly ash and wasted cooking oil with additional latex. Dasphalt included in bioasphalt due to renewable materials.

2.1.3 Damar Resin

Damar is a natural resin produced by plants Dipterocarpaceae (genus Shorea, Hopea, Balanocarpus and Vateria) and Burseraceae (clan canarium) based on several references [2].

Asphalt composition comprised of asphaltenes which is material in black or dark brown and maltenes which is a viscous liquid consisting of resins and oils. Damar is a major component in dasphalt as a natural resin, has a hardness depending on the temperature of the so-called thermoplastic properties. The function is as a resin binder of dasphalt itself. Many say the least influential resin mixture. The resin used is a resin that has been in the packaging in the form of powder [3].

2.1.4 Fly Ash

Fly ash (fly ash) is one of the residues generated in combustion and composed of fine particles. Abu who do not ride called bottom ash. In the industrial world, fly ash usually refers to the ash produced during the combustion of coal.

According to ACI Committee 226 explained that, fly ash has a fairly fine grain, which passes a sieve No. 325 (45 milli micron) 5-27%, with the specific gravity between 2.15 to 2.8 and blackish gray. Granules fine fly ash which has a large surface area so that it will be better in terms of the binding of (absorbent) impurities contained in dasphalt than brick powder used in the composition dasphalt earlier. Coal fly ash has been used as adsorbent in the preliminary parameters of pollutants in wastewater [2].

2.1.5 Wasted Cooking oil

Low quality edible oils in this research is the cooking oil that is not branded, without any *Halal* and foodgrade certification, expiration date, and other important informations. Cooking oil demand because they were cheaper and easily found in traditional markets.

Based on the information from sources that quoted from Baihaqi [3], cooking oil that serves as a controller of an elasticity of dasphalt. More or less will affect the rate of hardening of dasphalt itself. In addition it also functions as a diluent oil and solvent during the production of dasphalt.

In general, the physical properties of damar among other fragile and easily attached to the hand at room temperature, soluble in essential oils and non polar organic solvents, slightly soluble in organic solvents, insoluble in water, can not stand the heat, flammable, not volatile when not decompose and can change color if kept too long in a closed place without good air circulation [4].

2.1.6 Latex

Latex is a term used to refer issued by the sap of rubber trees. Latex contained in the bark, leaves and seed integument rubber. Latex has rubbery properties. The chewy nature related to the viscosity or plasticity of rubber. The addition of the polymer latex to the composition as an elastomer or Plastomer dasphalt to add rigidity and elasticity dasphalt. Disadvantages dasphalt composition previously located at the lack of ductility under 100 cm as a condition for penetration bitumen, so the addition of latex is needed to increase the ductility of daspahlt.

The addition of natural latex is expected to improve the resistance to asphalt cracking after experiencing long-term aging. This is because the asphalt becomes more elastic and their termination polymer molecule chains of natural rubber during the short-term aging process that reduces the brittleness of asphalt [5].

2.2 Research Method

The method used is an experimental method to the test object dasphalt with a mixture of damar resin, fly ash, and wasted cooking oil, which is used as a binder layer of asphalt concrete (laston) compared to asphalt penetration. Testing standards used are:

1.SNI 06-2456-1991 (Penetration Test).
2.SNI 06-2434-1991 (Softening Point Test).
3.SNI 06-2433-1991(Flash Point Test).
4.SNI 06-2441-1991 (Specific Gravity Test).
5.SNI 06-2432-1991 (Ductility Test).
6.PA-0312-76 (KVBB-V-19) (Affinity Test)
7.SNI 06-2438-1991 (Solubility Test)

3. Results and Discussion

3.1 Materials composition

The composition of materials to be blended for producing dasphalt is prsesented in Table 1. These composition are modified from the previous research conducted by Muhammad Fachri [1].

Table 1. Modified Dasphalt Compotitions

Code	Material			
	Damar resin (g) (powder +solid)	Fly ash (g)	Wasted cooking oil (r)	Latex (%)
S1	350+100	150	205	0
S2	350+100	150	205	2
S3	350+100	150	205	4
S4	350+100	150	205	6
S5	350+100	150	205	8
S6	350+100	150	205	10

The various composition were then subjected into bitumen tests characterization included penetration test, softening point test, ductility test, flash point test, specific gravity test, solubility and afinity test. The results are sumerized in Table 2.

Table 2. Summary of Testing Characteristics of Damar Asphalt Modified Compared with Asphalt Penetration Specifications

Test	Unit	Asphalt Specification			Results of test					
		Pen 40	Pen 60	Pen 80	S1	S2	S3	S4	S5	S6
Penetration test	10^{-1} mm	40 - 59	60 - 79	80 - 99	68	62	43	36	31	29
Softening point test	˚C	51 - 63	40 - 58	46 - 54	55.5	55.5	57.5	65.5	68.5	69.5
Ductility test	Cm	100	100	100	63.5	76.5	119.5	78.5	11	6.5
Flash point test	˚C	200	200	225	240	258	260	250	250	245
Specific gravity test	g/mm	1	1	1		0.99	0.98	0.97	0.97	0.96
Solubility test	%	99	99	99				95		
Affinity test	%	99	99	99				99		

Asphalt composition comprised of asphaltenes which is material in black or dark brown and maltenes which is a viscous liquid consisting of resins and oils [1]. Therefore, damar resin plays an important role in making dasphalt mixture. The function is as a resin binder of dasphalt itself.

Fly ash that serves as filler and as absorden dasphalt work by removing impurities contained in dasphalt mixture during cooking so that the results obtained mixture dasphalt purer. Fly ash is not completely lost during the cooking process but still contained in the composition dasphalt evident when solubility testing in solution trichlore ethylene were conducted, the results of the test show that dasphalt only 95% is dissolved. The 5% is fly ash which is a non-hydrocarbons do not dissolve in solution trichlore ethylene.

Wasted cooking oil as diluent of asphalt mixture also plays a role in reducing the elasticity dasphalt plastic traits possessed by the resin.

3.2 Latex content determination

The polymer of latex is added into the ingredient to achieve the requirement of the ductility test. Figure 1 present the role of latex into the damar asphalt penetration. The effect of latex addition into the ingredient decrease the penetration of damar asphalt.

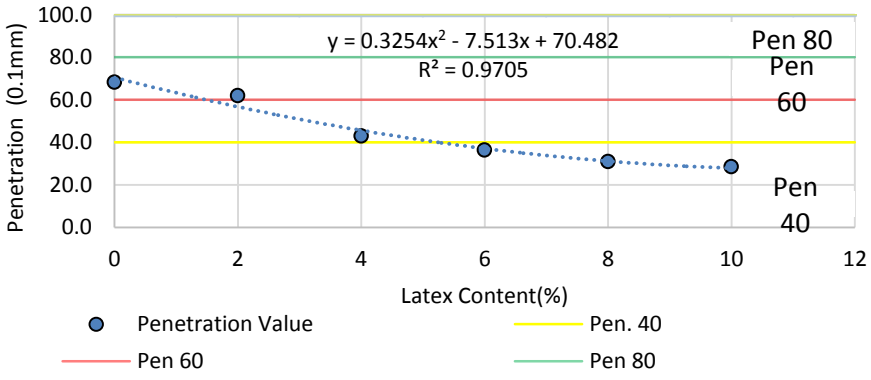

Figure 1. The effect of latex content on the penetration of dasphalt

Figure 2 shows the effect of latex addition into the softening point of damar asphalt. The addition of latex increase the softening point of the ingredient.

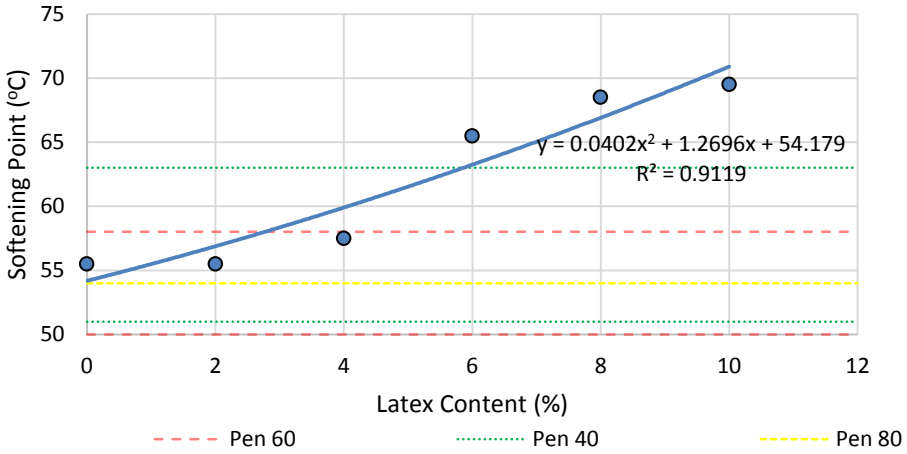

Figure 2. The effect of latex content on the softening point of dasphalt

The main objective of latex addition is to increase the ductility test, which is the shortcoming of pure damar asphalt, it could be seen in Figure 3 that by adding a latex content of 4% the ductility of dasphalt could be more than requirements of 100cm.

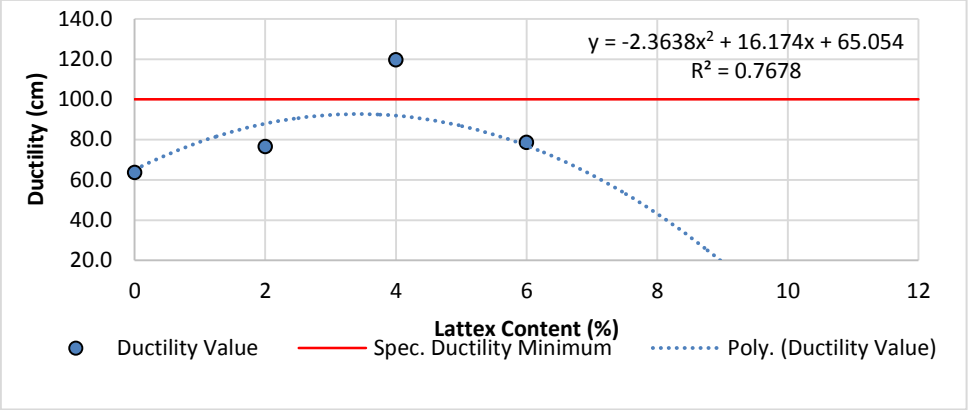

Figure 3. The effect of latex contents on the ductility of dasphalt

As expected, the addition of 4% polymer latex could improve the softening point and ductility tests results by increasing the value of softening point and ductility to full fill the requirements of 40 penetration with the sufficient value of 55°C and 119cm, respectively.

4. Conclusion

Based on the results of several investigations that have been carried out on damar asphalt composition that meets the requirements of penetration bitumen pen 60/70 is dasphalt composition with damar resin (damar resin powder 350g + solid damar 100g), fly ash 0%, wasted cooking oil 205g with latex content of 0% and 2%, but for ductility requirements of both the composition is not qualified.

The most optimal composition obtained in this test is the composition of damar resin (damar resin powder 350g + solid damar 100g), fly ash 0%, wasted cooking oil 205g with latex content of 4% with a penetration value of 43, the value of the softening point of 57.5°C, the value a flash point of 260°C, the value of the burning point 275°C, the ductility 119.5cm and an affinity of 99%. The composition

does not meet the requirements for specific gravity of 0.97 and a solubility of only 95%, but due to the value of penetration of just 43pen, the most optimal composition is more similar to asphalt 40 penetration.

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