EXPERIMENTAL STUDY ON STABILITY OF EMULSION ASPHALT MIXTURE MADE WITH EXTRACTED BITUMEN OF BUTON NATURAL ROCK ASPHALT (EB-BRA)

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Abstract— Buton natural rock asphalt (BRA) consists of 30% of bitumen and 70% of mineral. Extracted bitumen of BRA (EB-BRA) was blended with cationic emulsion, kerosene, chloride acid, calcium chloride and water to produce asphalt emulsion. Marshall specimens were used to study the stability of emulsion asphalt mixture containing EB-BRA. The test showed that the application of asphalt emulsion made with EB-BRA in the production of asphalt concrete wearing course mixture result in a proper stability. Furthermore, the increasing of curing time led to stability development and flow decline in all asphalt emulsion mixtures

Keywords— Asphalt emulsion, Extracted bitumen of Buton natural rock asphalt (EBBRA), Stability, Flow.

I. INTRODUCTION

The southern areas of Buton island, Indonesia contain deposit of the sedimentary rock possess of hydrocarbon substances. The natural rock asphalt resources are approximately 60,991,554,38 tons (24,352,833,07 barrel oil equivalent) (Suryana A, 2003). Natural rock asphalt is composed of approximately 30% bitumen and 70% mineral. In recent years, the refining process has been developed to extract and recover the bitumen out of the rock to produce pure bitumen (Zamhari, et.al, 2014 and Furqon, 2012). In this study the bitumen is referred to extracted bitumen from Buton rock asphalt (EB-BRA).

Significant improvements and developments have occurred over the years to make quality bituminous emulsion products and their subsequent application in the field (A. James, 2006). Many research studies conducted by Chevron Research Company in California revealed that the curing periods of asphalt emulsion mixture in the field might take from 2-24 months (LD. Cold ,1994 in A. Al Hdabi et al., 2013)

This paper presents the utilization of EB-BRA as droplet phase to produce bitumen emulsion mixtures. The main objective of this paper is to study the influence of bitumen emulsion mixtures containing EB-BRA on the Marshall stability and flow. Furthermore, Marshall stability with flow at 1, 3, 7 and 60 days were studied in order to define a correct time-dependent curve of mixture with Marshall stability development of different asphalt emulsion contents.

II. MATERIAL AND TESTING

2.1. Characteristics of EBBRA

EB-BRA consists of carbon, sulfur and oxygen with amount of 88.8%, 3.9% and 7.3%, respectively. Table 1 shows the physical properties of EBBRA. Most of EBBRA properties meet the penetration bitumen grade 80/100. Chemical ingredients and physical properties of EB-BRA are mostly similar with chemical ingredients and physical properties of petroleum bitumen.

Table 1: Properties of EBBRA

Properties	Testing Result
Penetration on 25°C, 100 g, 5 dtk, 0,1 mm	93.2
Soft point, °C	48
Solubility on C_2HCl_3, % weight	97.6
Surt weight, gr/cc	1.05
Lost weight 163°C (TFOT), % weight	0.25
Penetration on TFOT, % pure	145.4
Viscocity 170 Cst	4

2.2. Characteristics of Aggregates

Two fractions of natural coarse aggregates from crushed river stone were used; one with aggregate diameter 5-10mm and the other with aggregate diameter10-20mm. River sand and stone dust obtained from stone crushed process were used as fine aggregate and filler, respectively. The properties of coarse aggregates, fine aggregate and filler are shown in Table 2, Table 3 and Table 4, respectively.

Table 2: Properties of Coarse Aggregate

Properties	(Crushed Stone) 0,5 - 1 (cm)	1 - 2 (cm)
Water absorption, %	2.071	2.08
Bulk specific gravity	2.622	2.627
Saturated surface dry specific gravity	2.677	2.682
Apparent specific gravity	2.773	2.779
Flakiness index, %	20.1	9.38
Abrasion aggregate, %	25.72	24.36

Table 3: Properties of Fine Aggregate

Water Absorption, %	2.792	
Sand Equivalent, %	89.66	
Bulk spesicific gravity	Saturated surface dry specific grafity	Apparent specific gravity
2.449	2.518	2.629

Table 4: Properties of Mineral Filler

Water Absorption, %	2.283	
Sand Equivalent, %	69.57	
Bulk spesicific gravity	Saturated surface dry specific grafity	Apparent specific gravity
2.595	2.654	2.758

2.3. Bitumen Emulsion Containing EBBRA

Bitumen emulsion containing EBBRA is shown in Table 5. The emulsion complied standard of ASTM and SNI-Indonesia. The concentration of solid phase EB-BRA and kerosene were 57.4% and 5%, respectively. The liquid phase was using 1% of emulsifier, chloride acid 0.5%, calcium chloride 0.1% and water 36%, respectively.

Table 5: Bitumen Emulsion Containing EBBRA

Material Anaysis	Composition Experiment (%)
EBBRA	57.4
Kerosene	5
Emulsifier	1
Water	36
Chloride acid (HCl)	0.5
Calcium chloride (CaCl)	0.1

2.4. Combined Aggregate Gradation

The combined aggregate gradation is shown in Fig.1. The combined aggregate gradation for all mixtures with different EB-BRA content was kept constant to facilitate the comparison of the test result.

2.5. Mixtures Design

The mixtures were all prepared in the laboratory. The contents of asphalt emulsion were 4.5%, 5%, 5.5%, 6% and 6.5% of the total weight of the mixture. Table 6 and Table 7 show the mixtures by weight and in percent, respectively.

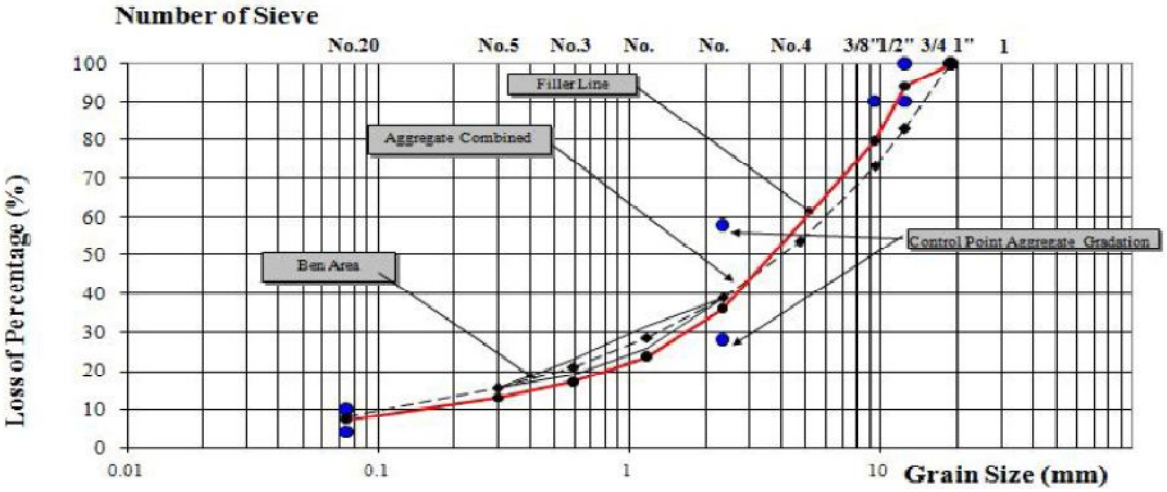


Figure 1 Combined aggregates gradation

Table 6: Material Composition in Weight

Asphalt Content (%)	Aggregate (gram) Crushed Stone 1-2 cm	Crushed Stone 0.5-1 cm	Fine Aggregate	Mineral Filler	Asphalt (gram)	Total Weight (gram)
4.5	217.7	412.6	492.8	22.9	54.0	1200
5	216.6	410.4	490.2	22.8	60.0	1200
5.5	215.5	408.2	487.6	22.7	66.0	1200
6	214.3	406.1	485.0	22.6	72.0	1200
6.5	213.2	403.9	482.5	22.4	78.0	1200

Table 7: Material Composition in Percent

Asphalt Content (%)	Aggregate (gram) Crushed Stone 1-2 cm	Crushed Stone 0.5-1 cm	Fine Aggregate	Mineral Filler	Asphalt (gram)	Total Weight (%)
4.5	18.1	34.4	41.1	1.9	4.5	100
5	18.1	34.2	40.9	1.9	5.0	100
5.5	18.0	34.0	40.6	1.9	5.5	100
6	17.9	33.8	40.4	1.9	6.0	100
6.5	17.8	33.7	40.2	1.9	6.5	100

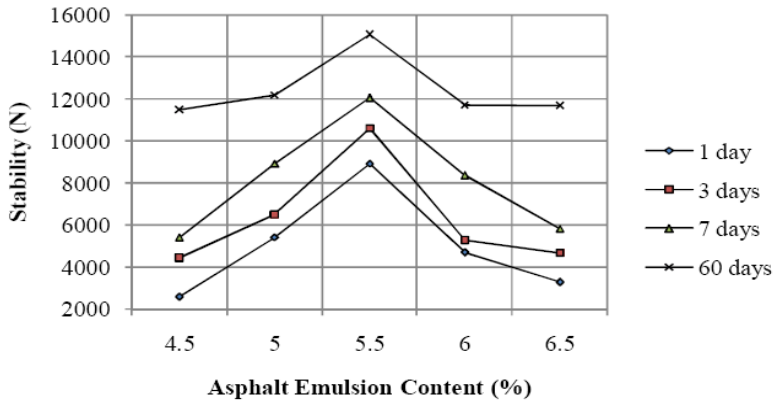


Figure 2 Relationship between asphalt emulsion content with stability

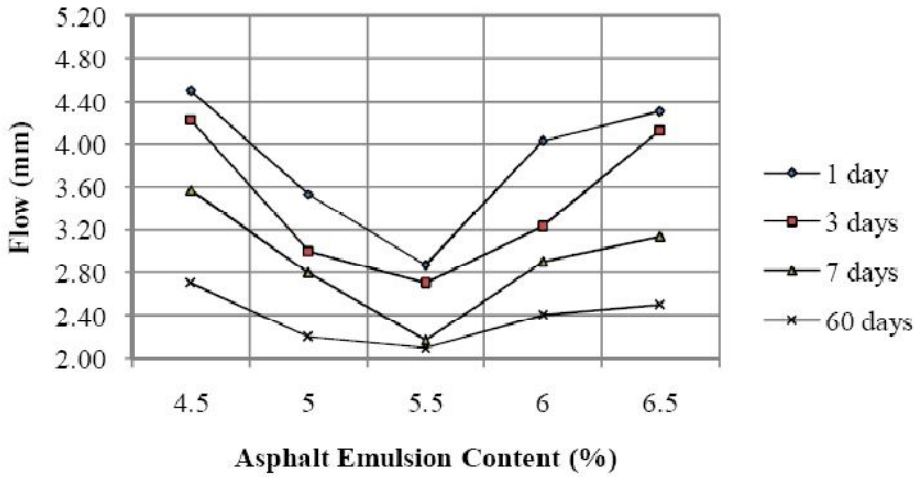


Figure 3 Relationship between asphalt emulsion content with flow

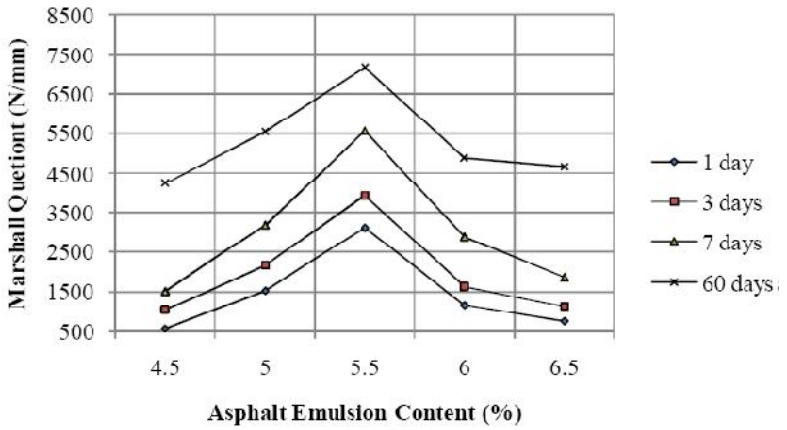


Figure 4 Relationship between asphalt emulsion content with marshall quetiont

III. RESULTS AND DISCUSSION

3.1. Marshall Test

Marshall Stability with flow tests were conducted on asphalt emulsion mixture in sample of 100 mm diameter and approximately 63.5 mm height by applying 75 blows on each face as per SNI (Indonesia Nasional Standard) procedure (SNI 06-2489-1991).

3.1. 1. Relationship between asphalt emulsion content with stability

After compaction, the stability of asphalt emulsion mixture containing EB-BRA can be established due to the contact between the EB-BRA droplet and mineral, led to induce the EB-BRA breakdown on the aggregate.

Figure 2 indicates that the Marshall stability of asphalt emulsion mixtures increases initially, reaches a maximum value and then decreases with increasing of asphalt emulsion content. Asphalt emulsion mixture is a multi-phased composite material consisting of aggregates and bitumen emulsion. Therefore, excessive asphalt emulsion may not disperse uniformly, while coagulate together to form weak points inside the mixture. As a result, stability decreases at high asphalt **e**mulsion contents. At 1 day curing, when the asphalt emulsion content was 5.5%, the marshall stability was 50 kN, therefore the asphalt emulsion content of 5.5% is adopted as the optimal asphalt content. Furthermore, at all asphalt emulsion content, the Marshall stability increased with increasing curing time, indicating that the curing time govern the adhesive and cohesive of asphalt emulsion resulting in development of Marshall stability. Figures 2 clearly shows the effect of curing time on Marshall stability development of all mixtures. When using 4.5% asphalt emulsion in the mixture, the Marshal stability percentage increases were 72.58%, 111.29% and 347.58% at 3, 7 and 60 days, compared with the corresponding one at 1 day. In comparison with the Marshall stability value at 1 day, the Marshall stability value at 3, 7 and 60 days increased by about 20.30% , 64.73% and 125.34%, respectively for mixture containing 5% asphalt emulsion. When 5.5% of asphalt emulsion was used in the mixture, the average Marshal stability values at 3, 7 and 60 days, compared with the corresponding one at 1 day, range between 19.09%, 35.03%, and 68.90%, respectively. The Marshall stability values increase at 3, 7 and 60 days increased by about 12.34% , 58.71% and 40.20%, respectively for mixture containing 6 % asphalt emulsion in comparison with the Marshall stability value at 1 day. At mixture containing 6.5 % asphalt emulsion, the Marshal stability percentage increases were 42.92%, 78.03% and 256.81% at 3, 7 and 60 days, compared with the corresponding one at 1 day.

3.1. 2. Relationship between asphalt emulsion content with flow

As shown in Figure 3, flow value of mixtures decreases by adding asphalt emulsion content and reached its minimum when asphalt emulsion content is 5.5%, then tended to increase. With increase of curing time, owing to the stiffness of asphalt emulsion mixture, the mixes become less flexible and the resistance to deformation increases resulting in a low flow value.

3.1. 3. Relationship between asphalt emulsion content with marshall quetiont (MQ)

Marshall Quotient (MQ) also known as stiffness ratio of stability to flow value of the mixture and the Marshall Quotient values of asphalt emulsion mixture with different asphalt emulsion contents are shown in Figure 4. It is found that the asphalt emulsion mixture at 5.5% asphalt emulsion contents provided the proper improvement of Marshall Quotient.

CONCLUSIONS

This present research to marshall test to study the stability, flow and marshall quetiont (MQ) of asphalt emulsion from extracted bitumen Buton rock asphalt (EBBRA).

1. All asphalt emulsion mixture containing EB-BRA can be compacted to create the bonding between bituminous asphalt binder and aggregates.
2. The increasing of curing time governed positively the stiffness of mixtures, resulted in stability development and decreased the flow in all asphalt emulsion mixtures.

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