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Bagasse-Ash as Filler in HRS (Hot Rolled Sheet) Mixture

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ABSTRACT

HRS (Hot Rolled Sheet, usually called as Lataston in Indonesia) is a modification of HRA (Hot Rolled Asphalt) mixture. Bagasse-ash is a combustion residual of sugar-cane with only 1% weight-loss and contains 73% silica. Hence, it can be used as a substitute of fine aggregate. Previous research indicate that Bagasse-ash mechanical properties (weight-density, aggregate size, fine aggregate absorption, sand-equivalent) have fulfill the requirements as a filler in HRS mix. This research aimed to analyze the use and influence of Bagasse-ash as a filler in HRS mixture. Result indicates that Bagasse-ash is suitable as a filler based on testing with a variety of Bagasse-ash and cement content (Marshall-stability test 1205.040 kg; flow test 4.427 mm; Marshall-Quotient 273.717 kN/mm; VMA 20.249%; VFA 74.206% and VIM 5.223%). HRS mixture with a variation of filler containing 60% Bagasse-ash is the optimal mixture based on the testing results.

Keywords: Bagasse-ash, Hot Rolled Sheet, Hot Rolled Asphalt, filler

1) INTRODUCTION

Asphalt is a mixture of aggregate, bitumen and filler. It is commonly used for all kinds of roads and parking areas (Murana et al., 2013). HRS (Hot Rolled Sheet, usually called as Lataston in Indonesia) is a modification of HRA (Hot Rolled Asphalt) mixture. It contains open-graded aggregate and high bitumen content (Directorate General of Highways, 1976). Therefore, it can be classified as a non-structural pavement and the quality majorly depends on its bitumen content. Water-resistant properties of HRS can hinder the infiltration process of both water and air, lead to the delaying of oxidation process (Public Works Department, 1999).

Aggregates in asphalt mixture consist of coarse aggregate, medium aggregate and fine aggregate (sand). Commonly, these aggregates were obtained by splitting natural stone to stone crusher machine. In asphalt mixture, aggregate occupies 86-93%

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of total weight (about 75-84% of total volume). Fine aggregate should be more or less in accordance with the required gradation which passes the size of 9.5 mm and retained on the size of 0.0075 mm (Transportation-Infrastructure Research & Development Center, 2005).

Filler is needed to stabilize the asphalt mixture. Asphalt mixture design is incomplete without filler. Filler is commonly selected for its ability to improve the adhesion between binders and aggregate (Imam, 2010). Various waste products can been used for several purposes, such as the replacement for a filler or binder material. These waste products can include industrial, agricultural and municipal solid waste. All these wastes should not be incinerated or discarded, but all of them can be utilized (Murana et al., 2013). These utilization of waste products can solve not only the environmental issue due to its disposal, but also can increase its economic value (Huwae and Tanijaya, 2013).

Bagasse-ash is a combustion residual of sugar-cane with only 1% weight-loss and contains 73% silica. It can be categorized as a fibrous waste-product with ethanol vapor. It contains unburned carbon along with the other constituent presented in Portland cement (Mohammed et al., 2009). The use of Bagasse-ash as a supplementary cementitious material to partially replaced Ordinary Portland Cement (OPC) not only helps reducing the methane emissions from organic waste, but also can improve its compressive strength (Sirirat and Supaporn, 2010). Previous research by Murana and Sani, 2015, shows that the mix containing 10% Bagasse-ash and 90% OPC at varying percentages of bitumen content have strength values which meet the standard specified in Asphalt Institute. The aggregate properties of Bagasse-ash has also fulfilled the required properties of bitumen as binder. Therefore, it can be used for asphalt pavement.

Both physical (size, shape and texture) and chemical composition (reactive silica and aluminous compound) of Bagasse-ash affect the improved compressive strength. Previous research by Osinubi and Thomas, 2007, shows that the tropical black cotton clay treated with a 10% of Bagasse-ash by weight of dry soil can increase soil strength properties. Therefore, Bagasse-ash with all its advantageous properties can be used as a substitute of fine aggregate. Previous research indicate that Bagasse-ash mechanical properties (weight-density, aggregate size, fine aggregate absorption, sand-equivalent) have fulfill the requirements as a filler in HRS mix (Mardhika, 2006).

Kebon Agung sugar factory in Malang, Indonesia, can produce Bagasse-ash approximately 2737 tons/year. It should be used economically by utilizing Bagasse-ash as a filler in asphalt mixture. Therefore, it will provide a fairly high economic value in addition to overcoming the existing waste. Bagasse-ash is also usually used as soil embankment for housing construction in the area surrounding the plant. Kebon Agung sugar factory, as a factory of sugar-cane processing, produce the waste (Bagasse-ash) which can be a source of pollution if not treated in proper ways of waste handling. The disposal of Bagasse-ash into the river is one example of the lack of waste treatment (Riza, 2001). This research aimed to analyze the use and influence of Bagasse-ash as a filler in HRS mixture.

2) BAGASSE-ASH

Bagasse-ash is a combustion residual of sugar-cane which is used as fuel for the steam boiler. The steam boiler is a designed tool and combination of many equipment working in a system to produce steam. Inside the steam boiler there is a fuel burning equipment which transforms the burning process to thermal power. This is where Bagasse is used as a fuel for later reduced to Bagasse-ash. The processing of Bagasse-ash can be explained as:

- Sugar-cane in a period of harvest is cut and transported to the grinder in sugar factory.
- Then it is milled to drain its sugar-water content.
- The residual of sugar-cane is then used as fuel for the steam boiler.
- The combustion residual of sugar-cane from the steam boiler is produced what is called as Bagasse-ash.

Table 1 and 2 show the mechanical properties and chemical composition of Bagasse-ash based on the research result of Hall Industrial Research and Development Surabaya (Riza, 2001).

3) METHODOLOGY

3.1. Material

The experiment sample consists of several materials, such as:

- Crushed stone from a quarry and stone is obtained in Wai Sakula, Ambon, with a size of 10-20 and 5-10 mm.
- Fly-ash is obtained form the stone grinding place in Wai Sakula, Ambon.
- Bagasse-ash is obtained from Kebon Agung sugar factory, Malang.
- Asphalt used is solid asphalt, usually called as asphalt cement with penetration 60-70.

Table 1. Mechanical properties of Bagasse-ash

Item	Percentage (%)
Water content	3.79
Ash content	79.03

3.2. Analysis method

The standard process of asphalt mixture is used in this experiment and also commonly used in HRS:

- Coarse aggregate: gravel (crushed stone 10-20 mm and 5-10 mm).
- Fine aggregate: sand + fly-ash.
- Filler and asphalt.

Standard asphalt mixture is created to determine the optimum bitumen content in the mixture, which is then used as the asphalt mixture by using a filler (Bagasse-ash). The variation mixture of Bagasse-ash is 20%, 40%, 60%, 80% and 100%, with each variation of 15 specimens. The variation is used to determine the optimal composition of Bagasse-ash as filler which is tested using the Marshall parameters, such as Marshall-stability test, flow test, Marshall Quotient test and Volume of Air Void test. Then there are controlled with the HRS specification standard.

Table 2. Chemical composition of Bagasse-ash

Item	Percentage (%)
Carbon	10.91
Silica (SiO_2)	72.33
Magnesium	0.58
Calcium	0.63
Alumunium (Al_2O_3)	3.24
Ferrum	0.85

4) RESULTS AND DISCUSSION

Testing result of Bagasse-ash variation as filler using Marshall-method is shown in Table 3. All these Marshall parameters meet the requirements in the specifications of the HRS mixture (Transportation-Infrastructure Research & Development Center, 2005). It is shown that the variation of 60% Bagasse-ash acquires the Marshall parameters higher than the others. Then it can be concluded that the HRS mixture with a variation of filler containing 60% Bagasse-ash is the optimal composition.

Tabel 3. Testing result of Bagasse-ash variation as filler using Marshall-method

Marshall Parameter	HRS specification	% Bagasse-ash				
		20	40	60	80	100
Marshall Stability	Min. 800	1049.30	1077.32	1205.04	1125.61	1048.97
Flow	Min. 2	4.47	4.50	4.43	4.53	4.49
Marshall Quotient	Min. 200	237.68	240.13	273.72	250.58	236.43
VMA	Min. 18	24.55	24.45	24.07	24.23	24.38
VFA	Min. 68	75.15	74.58	77.15	76.49	75.86
VIM	3 – 6	6.10	5.97	5.50	5.69	5.89

The use of 60% Bagasse-ash as a filler in asphalt mixture has the lower Marshall parameters than the standard asphalt mixture. These results is shown in Table 4. Therefore, the standard asphalt mixture has the better quality than the asphalt mixture using 60% Bagasse-ash filler. Though the Marshall parameters are lower but it has fulfill all the standard requirements of HRS mixture. Therefore, Bagasse-ash can still be classified as a suitable replacement of standard filler in asphalt mixture.

Tabel 4. Comparison result of standard mixture to the use of 60% Bagasse-ash filler

Marshall Parameter	**HRS specification**	**Item**	
		Standard mixture	**60% Bagasse-ash**
Marshall Stability	Min. 800	1467.328	1205.040
Flow	Min. 2	4.413	4.427
Marshall Quotient	Min. 200	333.623	273.717
VMA	Min. 18	24.432	20.249
VFA	Min. 68	75.645	74.206
VIM	3 – 6	5.951	5.223

5) CONCLUSION

The HRS mixture with a variation of filler containing 60% Bagasse-ash is the optimal composition than the others (20%, 40%, 80% and 100%). Result indicates that Bagasse-ash is suitable as a filler based on testing with a variety of Bagasse-ash and cement content (Marshall-stability test 1205.040 kg; flow test 4.427 mm; Marshall-Quotient 273.717 kN/mm; VMA 20.249%; VFA 74.206% and VIM 5.223%). The use of Bagasse-ash as a filler can both reduced the needs of cement filler and provide a fairly high economic value in addition to overcoming the existing waste.

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