

A Brief on Potential of Ternate Coconut Shell Waste as Asphalt Aggregate Mix Filler

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Abstract— North Maluku's status as one of the largest coconut producers in Indonesia shows that coconut deposits in the North Maluku region are relatively abundant. This makes many people who work as coconut traders. Most traders peddle coconut in urban areas. Environmental problems arise from this condition, namely the accumulation of coconut waste in urban areas. The Environment Agency has tried to control this condition with various methods, but it is still not effective. This study was conducted as an effort to utilize coconut waste in Ternate City as a useful material for Ternate City. The method used in this study is an experiment by comparing the characteristics of the asphalt aggregate mixture without filler and using filler. The results obtained from the Marshall test indicate that the use of filler derived from coconut waste can increase the stability value of the asphalt aggregate mixture. This indicates that there is potential behind the accumulation of waste that occurs in the urban area of Ternate. Thus, coconut waste can be used to support development in Ternate City.

Keywords— Put your keywords here, keywords are separated by semi colon.

I. INTRODUCTION

Coconut (*Cocos nucifera*) is a social commodity whose development has traditionally been passed down from generation to generation in the archipelago, besides that it is an important commodity and has economic value because the leaves, fruit and stems can be utilized. North Maluku has an area of 200,813 ha of coconut plantations, all of which are smallholder plantations with a total production of 208,518 tons.

The coconut industry can increase the added value of the economy of Ternate City, North Maluku Province. Nationally, coconut production in North Maluku from 2014 to 2016 still ranks fourth after Riau, North Sulawesi and East Java.

But unfortunately, coconut fruit traders are reluctant to dispose of the coconut shell waste in a garbage dump, because they do not want to pay the waste retribution. In addition to spoiling the view and disturbing activities, coconut husk waste is a problem that is not easily solved by the Ternate City Government (Pemkot) [1].

This is due to the fact that the traders do not comply with established procedures such as paying a garbage retribution. As a result, a lot of coconut waste is scattered and piled up in the urban area of Ternate.

II. LITERATURE REVIEW

A. Coconut Production in Ternate

Coconut plant products, in addition to meeting the needs of the community, are also a source of foreign exchange through exports. In addition, this commodity can absorb a large number of workers, which is around 6.9 million families [2].

Apart from being a source of vegetable oils and fats, coconut plant products as a source of raw materials for various other industries, such as coconut milk, fresh coconut, various

types of oleo chemical, various products from coir and coconut shells, have good market prospects [3].

From the several research, coconut oil, especially VCO, is also good for health. In addition, coconut oil can be used for energy substitution, namely for biodiesel and fuel oil. Thus, coconut development centers are very possible to develop coconut oil-based energy supply [4].

In North Maluku, coconut is only used as a primary product, either in the form of fresh coconut or copra and as raw material for cooking oil. Product development efforts and utilization of by-products can increase the added value of coconut products which in turn will increase the income of coconut farmers [5].

Likewise, the land under coconut trees can still be utilized with diversification activities both with food crops and livestock. The efforts needed to develop coconut commodities include [3];

1. Identification of land area status, coconut production and productivity, types/varieties, pests and diseases/damage of coconut, land potential for development,
2. Identification of the economic value of coconut and its derivative products,
3. Description of investment opportunities for coconut development from upstream to downstream,
4. Formulation of strategies, policies, and programs for the development of coconut and its derivative products in North Maluku.

B. Asphalt Aggregate Mix

Asphalt is an adhesive material (cementitious), black or dark brown in color with bitumen as the main component. Asphalt can be obtained in nature or is also a residue from petroleum refining [6]. Asphalt is a commonly used material for binding aggregates in road pavement structures [7] [8].

Although asphalt is a small volume component compared to the components that make up asphalt concrete mixes, it is a crucial part in providing a durable bond and keeping the mixture in an elastic condition [9]. There are several qualities that must be possessed by asphalt to ensure satisfactory mix performance, including the following [10]:

1. Rheology

Rheology is the study of deformation, shape change and mass flow. Asphalt has two important rheological properties, namely thermoplastic and visco-elastic. Thermoplastic means that the asphalt viscosity decreases with increasing heat and vice versa increases with decreasing temperature [11]. Visco-elastic means that when the forces acting on the asphalt structure are distorted as to flow. Distortion is a reversible movement and is described as elastic behavior.

2. Cohesion

Cohesion is the ability to maintain bonds between fellow forms/compounds (asphalt). The ability of the cohesive power of an asphalt with a certain level of penetration is measured by a ductility test instrument at low temperature (room temperature) [12].

3. Adhesion

Adhesion is the ability to maintain bonds between the form of compounds with other compounds (asphalt with aggregates). The ability of asphalt adhesion is approximated by the Marshall Retained Strength Index [13].

4. Durability

Durability is the ability to maintain good rheological quality, cohesion and adhesion of asphalt. The factors that affect the durability of asphalt are Oxidative hardening, Evaporative hardening and Exudative hardening [14].

C. Coconut Waste as Filler

The importance of highway planning has been widely studied regarding the development and modification of asphalt by utilizing fillers from waste to make asphalt mixtures that are environmentally friendly [15]. In this study, the waste that was studied to be used as a filler is coconut shell waste. To be used as a filler in the pavement mixture, the

coconut shell waste must be processed first into charcoal powder [16].

Coconut shell charcoal powder is charcoal made by combining coconut shell and then crushed into powder. In the process of burning coconut shells which consist of very complex carbohydrates, it will cause a series of reactions, namely thermal decomposition [17] and generate heat as a result of the decomposition of various molecular structures [7].

At a temperature of 275⁰C, lingo cellulose begins to release H₂O and CO₂ [18], besides that, charcoal and methane are also formed [19]. The content of coconut shell charcoal powder in the form of nonpolar carbon compounds is the same as the carbon compounds in asphalt. Coconut shell charcoal is a local material that is easy to find [20].

III. METHODOLOGY

This study is an experimental study. In this study, the following are the steps taken to obtain the results

1. Preparation of tools and materials
2. Coarse aggregate and fine aggregate inspection
3. Manufacture of Marshall test specimens with variations in asphalt content
4. Making Marshall test specimens with additional filler

IV. RESULT AND DISCUSSION

The coarse aggregate used in this study was crushed stone with a size of 5 mm and 10 mm, while for the fine aggregate used was local sand. To obtain good asphalt, the gradation of the aggregate must meet the specified specifications, it is necessary to examine the physical properties of the aggregate as shown in the following table:

TABLE I
AGGREGATE TEST RESULTS

No	Properties	Methods	Requirement	Result	Note
Coarse Aggregate					
1	Absorption	SNI 03-1969-1990	Maximum 3%	2,86%	Passed
2	Specific Gravity	SNI 03-1970-1990	Minimum 2,5 gr/cm ³	2,74 gr/cm ³	Passed
Fine Aggregate					
1	Absorption	SNI 03-1969-1990	Maximum 3%	1,44%	Passed
2	Specific Gravity	SNI 03-1970-1990	minimum 2,5 gr/cm ³	2,60 gr/cm ³	Passed

Based on the overall aggregate test, it is known that coarse and fine aggregates can be used for asphalt mixtures because all tests have met the requirements. Meanwhile, the examination of the physical properties of asphalt is shown in the following table:

TABLE II
ASPHALT TEST RESULTS

No	Properties	Method	Requirement		Result	Note
			Min.	Max		
1	Penetration (mm)	SNI 06-2456-1991	60	79	65,7	Passed
2	Soft Point (°C)	SNI 06-2434-1991	48	58	53,5	Passed
3	Incinerate Point (°C)	SNI 06-2433-1991	200	-	219	Passed
4	Ductility (cm)	SNI 06-2434-1991	100	-	110	Passed

From the test results on the physical properties of asphalt, it is known that asphalt material can be used for asphalt mixtures because all tests have met the requirements.

Marshall testing of the optimum asphalt content was carried out to determine the stability and flow values, and was used to find the optimum asphalt content. The asphalt content used is the result of determining the approximate asphalt content of 4.5%, 5%, and 5.5%. The results of the Marshall Test on the optimum asphalt content are shown in the following table:

TABLE III
MARSHALL TEST RESULTS ON VARIED ASPHALT CONTENT

No.	Properties	Requirement	Asphalt Content (%)		
			4,5	5	5,5
1	VMA (%)	min. 15	61,34	58,19	61,04
2	VFA (%)	min. 60	15,32	18,97	18,18
3	VIM (%)	3,5 5,5	51,94	47,19	49,94
4	Stability (Kg)	min. 800	1325,19	1413,47	1285,31
5	Flow (mm)	min. 3,0	5,37	4,27	4,83
6	MQ (Kg/mm)	min. 250	247,91	331,62	267,15

From the table above, it is known that the Marshall Test results on the optimum asphalt content for asphalt mixtures of 5.5% with a VMA (Voids in Mineral Aggregate) value of 61.04%, for a VFA (Voids Fill Asphalt) value of 18.18%, for the value of VIM (Voids in Mix) of 49.94%, for the value of stability obtained by 1285.31 kg, for the value of melt (flow) obtained a value of 4.83 mm, and for the value of Marshall Quotient (MQ) obtained the result of 267,15 kg/mm.

Furthermore, Marshall testing of filler variations was carried out to determine the value of stability, and melt (flow). The filler content tested at each immersion time had variations

of 1%, 1.5%, and 2% with the number of each content being 3 test objects.

No.	Properties	Requirement	Filler Content (%)		
			1,0	1,5	2,0
1	VMA (%)	min. 15	62,18	61,96	63,61
2	VFA (%)	min. 60	18,37	18,53	17,26
3	VIM (%)	3,5 5,5	48,49	54,19	57,91
4	Stabilitas (Kg)	min. 800	1444,74	1422,82	1364,95
5	Flow (mm)	min. 3,0	5,57	5,60	4,97
6	MQ (Kg/mm)	min. 250	259,60	254,08	254,70

Based on the results of the marshal test carried out on the marshal test object using variations in filler content, it can be seen that the property values obtained between samples without filler and using filler have different values. With the presence of filler, the stability value of each mixture content increases with increasing filler content.

V. CONCLUSIONS

The use of filler material in the mixture of aggregate and asphalt can increase the stability value. In this case, it is proven that the filler derived from coconut shell waste can be used as a filler material that can increase the stability of the asphalt aggregate mixture. With these results, it can be concluded that the utilization of coconut waste in Ternate City can be done one of them by processing coconut waste into filler material to support local development using local waste.

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