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Hydrated lime addition effect on the stability and durability of modified open-graded friction course

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Abstract

An open-graded friction course is an asphalt mixture with a high percentage of coarse aggregates that are almost uniform in size, resulting in a high percentage of air voids, typically 15 to 20 %. The main advantages of the mix are increased safety due to increased frictional properties of the pavement surface and the ability of surface water to drain through the pavement. One of the disadvantages of an open-graded friction course is less stability, and a large void makes the layer easy to strip. An additional material that promises to increase stability and durability is hydrated lime. Therefore, this study aims, to investigate the effect of hydrated lime on a modified open-graded friction course on stability and durability. The method used in the study is the Marshall stability and particle loss test. The result shows that modification of the open-graded friction course with cellulose fiber and hydrated lime increases stability, and decreases particle loss.

Keywords

Open-graded friction course, Hydrated lime, Stability, Durability

Introduction

An open-graded friction course is a hot mix asphalt with a special function as a layer capable of draining surface flow runoff. This pavement course is suitable for use in environments with high rainfall. The layer is primarily used to improve safety by increasing the frictional properties of the pavement surface during wet weather [1] . This type of pavement has been widely applied in many countries but has not been applied in Indonesia. The regulations that overshadow it do not yet exist. Some of the advantages of OGFC are: reduced risk of hydroplaning' increased friction resistance, reduced backsplash and spray from vehicle tires, reduced noise, and improved visibility of pavement marking.

In comparison to conventional Dense Graded Hot Mix Asphalts (DGHMA) mixtures, these mixtures have higher air void (AV) contents (typically between 15% and 20%), gap aggregate gradations, stiffer binders, and higher binder contents. These high AV

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contents result in high permeability, which allows water to penetrate the structure through the interconnected AV and drain laterally at the interface with the underlying layer of the pavement and toward the structure's edge [2]. This condition causes OGFC to have weaknesses in stability and durability values. Raveling is a common symptom of durability issues, and once the distress begins, it progresses quickly. Therefore, OGFC has become one of the research hotspots for stability and durability while maintaining porosity. Efforts to replace aggregate materials with other types to improve the physical characteristics/stability of the mixture [3-8].

This research innovation was carried out using a material that can be an alternative to OGFC mix with high stability but can drain puddles. The added material used in the research is hydrated lime and bamboo fiber. The purpose of this study was to compare the stability and durability of unmodified and modified OGFC. Unmodified OGFC is made as a control test and modified OGFC is made by adding lime and bamboo fiber.

Methods

The research investigated the effect of adding lime to the OGFC mixture. The research hypothesis is that adding hydrated lime to the OGFC mix improves stability and durability. Therefore, in this study several specimens were made to prove the hypothesis, these specimens are:

1. Virgin OGFC as a control
2. Modified OGFC with bamboo fiber
3. Modified OGFC with bamboo fiber and hydrated lime

Figure 1 explains the stages and process of the experiment, and how to make the test specimen starting until complete. The materials used in the manufacture of specimens are:

1. Aggregate, basalt aggregate
2. Asphalt penetration 60/70
3. Bamboo fiber as a stabilizing material
4. Hydrated lime as a filler and stabilizer

The specification used in the study follows the Japanese open-graded friction course (OGFC) mixture. The methods used to achieve the research objectives are:

1. Marshal stability using standard test SNI 2489:2018/ ASTM D6927-06
2. Particle Loss refers to Tex-245-F

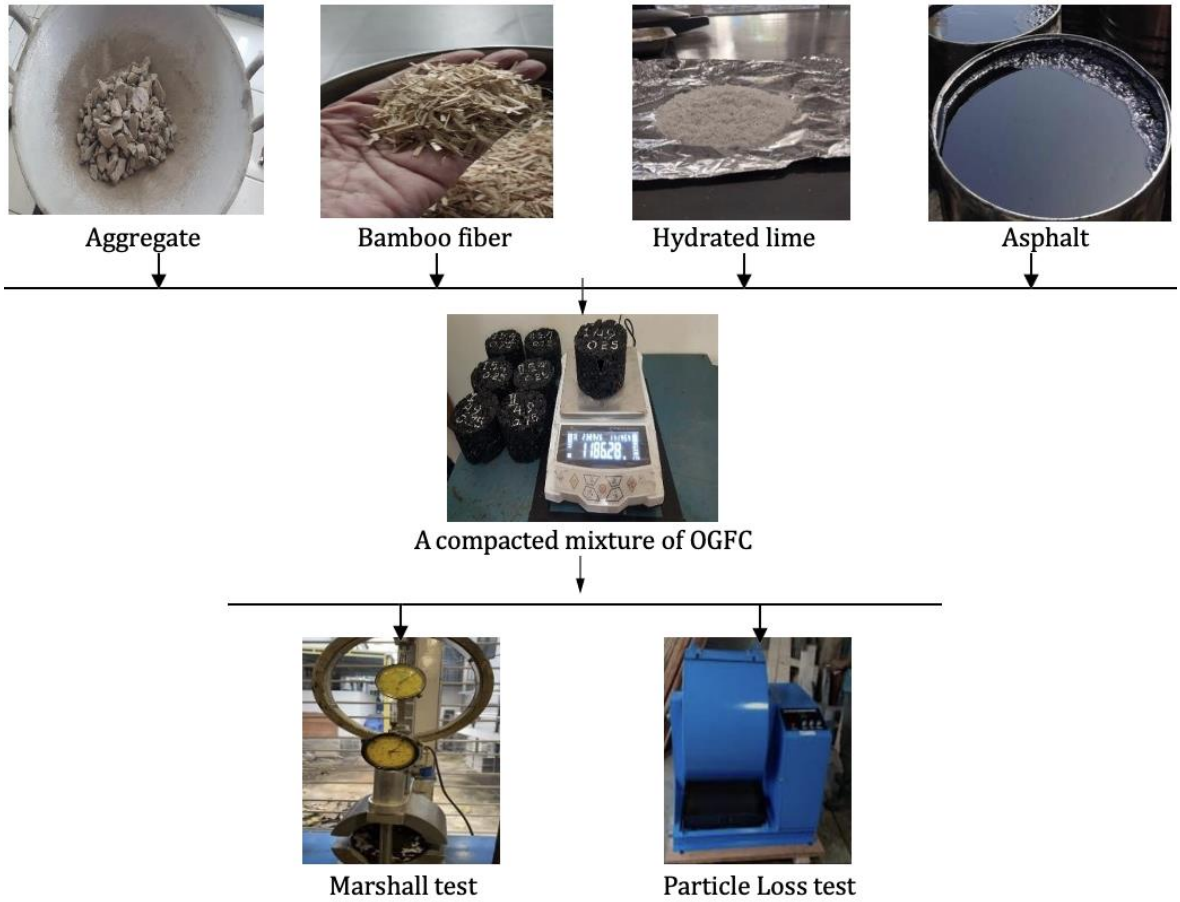

Figure 1. Experiment setup

Results and Discussion

All materials are tested for their physical characteristics to see their feasibility as OGFC blends. The results showed that the aggregates and other additional materials were to the Indonesia Highway Ministry specifications 2018. Furthermore, Marshall and Particle loss testing is carried out.

Marshall testing

The results of modification with bamboo fiber (BF) found that the optimal stability value was at 4.9 % asphaltcontent. Then such proportions are selected for modification with the addition of hydrated lime.

Figure 2 shows that adding HL to various variations in BF levels shows an increase pattern at HL levels of 0.5 % and 1 %. While the addition of 1.5 % shows an inconsistent pattern. The addition of HL shows variations in stability in each bamboo fiber content. It was shown that adding hydrated lime and bamboo fiber increased stability and achieved optimum levels at the addition of 0.5 % fiber and 0.5 % HL. At these proportions, the rate of increase in stability reached 214.72 %. In the proportion of HL addition of 0.5 % with a different proportion of BF, the average increase was 94.9 %. In mixtures without BF modification, the addition of HL led to an average increase of 1.36 % and the highest stability increase in the addition of HL of 0.5 % with an increased value of 1.88 %.

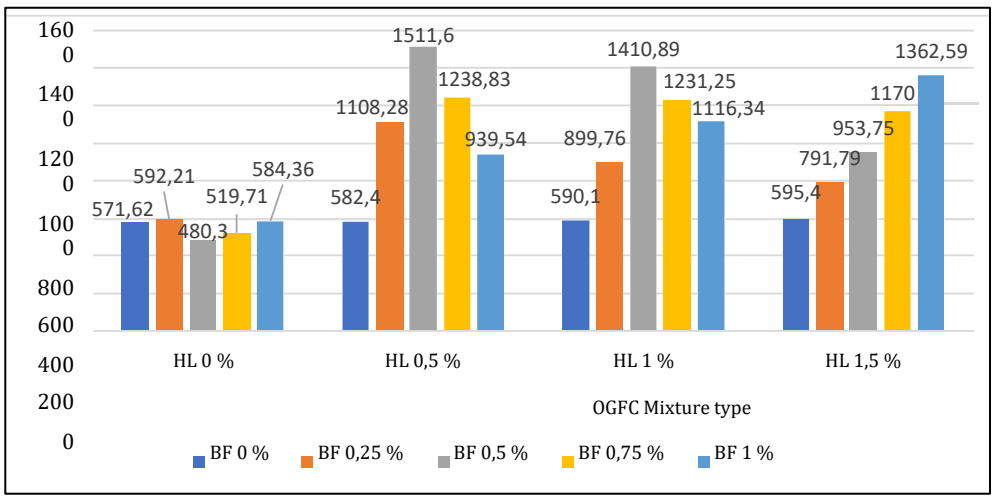

Figure 2. Stability of modification OGFC with bamboo fiber and hydrated lime

Particle Loss testing

The results of particle loss testing showed that the addition of bamboo fiber (BF) caused a tendency to decrease the value of particle loss (PL) (Figure 3). The lowest value of 9.5 % when the addition of fiber was more than 0.5 %, there was an increase in the PL value. The decrease in particle loss in fiber addition by 0.5 % reached 25 %of the original OGFC. The addition of hydrated lime (HL) shows a pattern of decreasing particle loss values, at each HL level and achieved the lowest value in HL increments of 1.5 %.

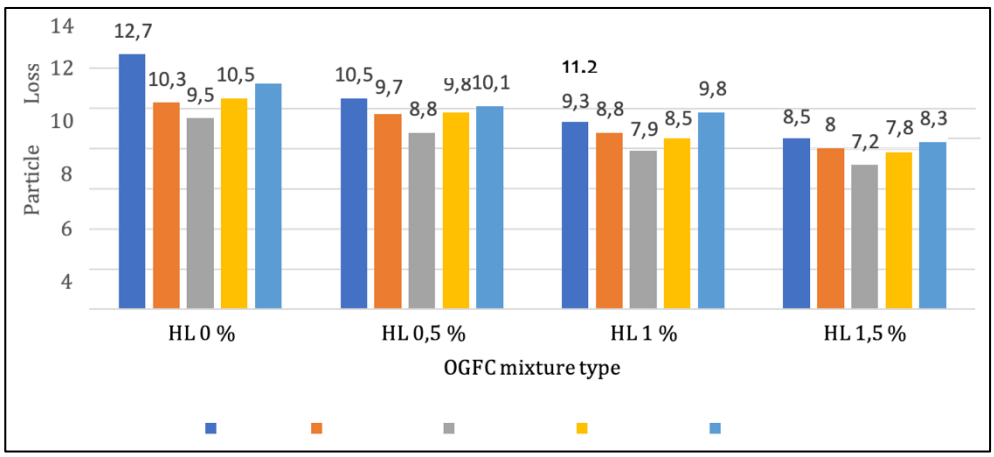

Figure 3. Particle loss of modification OGFC with bamboo fiber and lime

The limitation of the research is that there needs to be a further assessment of the feasibility of OGFC quality with an assessment of void in mixture conditions, permeability, and retained Marshall stability.

Conclusion

The conclusion of this study is adding hydrated lime to the modified OGFC mixture increases stability and achieves the optimal value incomposite asphalt content of 4.9 % and the addition of bamboo fiber 0.5 % hydrated lime by 0.5 %. Adding hydrated lime increases the durability of modified OGFC saw a decrease pattern in particle loss

value and reached the lowest value at the bamboo fiber content of 0.5 % and hydrated lime by 1.5 %.

Acknowledgments

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