The effect of applying waste cooking oil to the pore value of pavement

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Abstract. In this study, additive of waste cooking oil waste in the Asphalt Concrete-Wearing Course (AC-WC) mixture emphasizes the pore content of the asphalt mixture. In this study the application of waste cooking oil waste by 1%, 2%, 3%, 4%, and 5% of the optimum asphalt content. Judging from the mixed pore content in this study, it was found that by adding 1% the pore value was 4.61%; an additional 2% obtained a pore digit value of 4.64%; an additional 3% obtained a pore number value of 5.22%; at the addition of 4%, the pore value is 11.10%; and the addition of 5% obtained a pore number value of 11.47%. This indicates that the greater the level of addition of waste cooking oil waste, the higher the pore value obtained so that the mixture is less impervious to water and air so that the mixture will be more easily absorbed by water and oxidized. Thus resulting in accelerating the aging of the asphalt.

1. Introduction
The use of waste material that can be re-functioned as a reused item is increasingly being carried out, with no exception in the field of road pavement construction. One method to overcome or improve the asphalt pavement structure is the recycling method and can save the use of asphalt [1]. One of the causes of the decrease in the performance of the pavement is the change in environmental temperature which result in aging of the pavement layer [2]. The aim of this study was to analysis the pore content of the asphalt mixture by adding waste cooking oil [3]. In this study, testing was done in the laboratory by carrying out Marshall testing [4]. The utilizing of waste cooking oil as a lubricant of the asphalt layer has been investigated by several researchers by mixing at certain levels, including 0%, 10%, 30% and 60% [5].

2. Research methods

2.1. General description
To examine the adding waste cooking oil on asphalt mixture observed from Marshall test result. This study was conducted in several stages that are properties aggregate, asphalt, filler, Marshall Test. Moreover, stages of the research will be discussed in detail as follows.

2.1.1. The input stage. The first stage was conducted by collecting the secondary data.

2.1.2. The process stage. There were some activities which carried out in the process stage. The first was designing the planning mixture. Furthermore, testing by following the standardize and conducting
the analysis by comparing the test data with the standardise specification to get optimum bitumen content than add used waste cooking oil from percentage 1%, 2%, 3%, 4% and 5% of the optimum asphalt content.

2.1.3. The output stage. As conducted the study, in this stages, the conclusion of the research was given and recommendation was also given on the usage of waste cooking oil as additive observed pore value of the mixture.

2.1.4. Aggregate and gradation. 90% to 95% of the material contained in the pavement construction is an aggregate consisting of coarse aggregate and fine aggregate [6]. Coarse aggregate is the aggregate that is held in the 2,36 mm sieve while the fine aggregate is the aggregate that passes the 2,36 mm sieve and is held by #200 sieve. [7].

2.2. Bitumen
Asphalt serves as bining material for road construction, the asphalt used is asphalt with a penetration value of 60/70 which has superior quality which is commonly used for tropical climates such as in Indonesia [7]. The content of asphalt used in this road pavement layer is 5% as the initial basis for adding added materials [8].

2.3. Waste cooking oil
In this research, used waste cooking oil was used without any special treatment and then added to the asphalt mixture to see the performance of the asphalt mixture under different aging conditions. [9]. Waste cooking oil which is used to replace asphalt as a rejuvenating agent. Waste cooking oil is oil that has been contaminated by impurities such as water, fatty acids and other plymers. Waste cooking oil used obtained from household oil waste [6]. Waste cooking oils is a type of household and restaurant waste product that is wasted and becomes an environmental problem if not utilized [8].

2.4. Adhesive cracking
Whether cracking will be mainly adhesive or cohesive depends of the affinity of the mastic with the aggrerates [10]. This affinity is highly affected by acidity level, whether the aggregate are mainly positively or negatively charged and by the texture of the aggregate surface. Adhesion between a solid (aggregate particle) and liquid (bituminous mastic) depends on how much the solid and liquid “like each other” [9].

2.5. Pore value
Pore Value or Void In the Mix (VIM), which is the pore volume that remains after the asphalt concrete is compressed [11]. Pore value that is too large will result in asphalt concrete decreasing its watertightness, so that it results in an increase in asphalt oxidation process which can accelerate the aging of asphalt. While the pore value is too small, the pavement will bleed if the temperature rises. Pore is as a percent of the total volume of the mixture [12].

2.6. Binder performance
Asphalt as a binder which had been modified by applying waste cooking oil having functions as binder and rejuvenator of the asphalt layer [13]. The properties of binder changed when that waste cooking oil was applied into the mixture [14]. To evaluate its performance, dynamic shear, rheometer test, viscosity, softening point test and penetration test was done to identify the differences of the binder substances [15].

3. Results and discussion
This research was carried out by Laboratory testing. To obtain pore value test of Marshall was done. However the initial test must be conducted first. The test were specific weight and Absorption of
Rough Aggregate Water and Smooth Aggregate Type and Water Absorption. The former used SNI 03-1969-2008 and the later utilized SNI 03-1970-2008. After conducting the test, the result of coarse aggregate could be seen Table 1.

| Type of Testing                | Result | Term of Spec. |
|-------------------------------|--------|---------------|
| Specific gravity              | 2.63   | ≥2.5          |
| Aggregate water absorption    | 1.90   | <3            |
| Abration test                 | 36.20  | 40            |

Source: Result of Laboratory (2020)

From the research results, it was found that the coarse aggregate had the ability to absorb water and indicated that the coarse aggregate had a large pore content so that water was absorbed into the pore [10]. The results of laboratory testing of coarse aggregate obtained meet the specifications. In addition to the coarse aggregate used, this study also uses fine aggregate where fine aggregate must be tested for its properties value. The results of the fine aggregate properties test could be seen in Table 2.

| Type of Testing                | Result | Term of Spec. |
|-------------------------------|--------|---------------|
| Specific gravity              | 2,590  | ≥2.5          |
| The absorption of Aggregate Water | 1,870 | <3            |
| Sand Equivalent               | 61     | >50           |

Source: Result of Laboratory (2020)

From the research results, it was found that the fine aggregate used had the ability to absorb water and this indicated that the aggregate had a large pore content so that water was absorbed into the pore [3]. The results of laboratory testing of fine aggregate obtained meet the specifications. After all the materials have been tested for their properties and contents, coarse aggregate, fine aggregate and asphalt are mixed by applying waste cooking oil and Marshall testing was carried out in the laboratory to determine the characteristics of the mixture. The focus of the study in this research was to determine the pore value of the asphalt mixture added with waste cooking oil. From the research results obtained can be seen in Table 3.

| Adding waste cooking oil | Result |
|-------------------------|--------|
| 0%                      | 3.18%  |
| 1%                      | 4.61%  |
| 2%                      | 4.64%  |
| 3%                      | 5.22%  |
| 4%                      | 11.10% |
| 5%                      | 11.47% |

The relationship between adding percentage waste cooking oil 0%, 1%, 2%, 3%, 4% and 5% and pore value result is shown in Figure 1.
Figure 1. Effect of adding waste cooking oil.

Pore value states the percentage of cavities in the asphalt concrete mixture. Pore value can indicate the level of impermeability of the mixture [6]. In the table, it can be seen that increasing levels of additive plus percent results in increased results. So that it has a larger volume and the percentage of cavities on the mixture becomes smaller, the results of the pore value obtained at the third percent do not meet the requirements. This indicates that by applying waste cooking oil, the pore content of the pavement will increase so that the asphalt concrete reduces its water tightness, resulting in an increase in the asphalt oxidation process which can accelerate the aging of the asphalt.

4. Conclusion
The addition of waste cooking oil resulted in an increase pore value due to increased asphalt viscosity as a result asphalt cannot cover the cavities between the aggregates in the asphalt concrete mixture. This indicates that the greater the level of addition of waste cooking oil waste, higher the pore value obtained so that the mixture is less impervious to water and air so that the mixture will be more easily absorbed by water and oxidized. Thus, resulting in accelerating the aging of the asphalt.

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