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CIVIL ENGINEERING
COMPARATION OF BENDING STRENGTH CONCRETE FLOOR PLATE CFRP REINFORCING WITH WIRE MESH REINFORCING AN ALTERNATIVE THE BEST CHOICE FOR CONCRETE REINFORCING FLOOR PLATES

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ABSTRACT

Floor plate is one of the major structural elements of the building frame structure, as loadbearing gravity directly consisting of dead load, self weight and live load. As a result of this gravity loads will occur bending moment and will cause a sizeable deflection. To eliminate deflections occurring and to improve the flexural strength as resistance to the gravity loads, generally done by providing reinforcement as a reinforcement in the slab.

The development of Carbon Fiber Reinforced Polymer (CFRP) and Wire-mesh reinforcing has opened up new opportunities to provide rigidity and improve the flexural strength concrete frame structure of the building in general, in particular on the concrete floor plate elements. To select the material flexural the concrete floor slabs, researchers are trying mengkomparasi use of CFRP and Wiremesh as reinforcement bending, the specimen concrete slab dimensions panjang 1200 mm, width 500 mm and thickness of 120 mm, with the number of each of the three specimens of concrete plate bertulangan CFRP, and 3 specimens bertulangan Wire-mesh. Once the concrete specimen minimum age of 28 days, and then tested in experimental powe...
Standard actual dimensions of 1.20 X 15.00 X 250.00 mm, but the size is listed in the table can not be precise as standard. The reason is precisely because of the difficulty to form flat plate composed of fibers, the fiber edge plate plates apart so often can not be precise as wide as the width of 15.00 mm, however the size of the width is still within tolerance (Figure 1).

![Figure 1. CFRP specimen already formed (7 pieces) (Astawa, M.D, at al, 2015)](image1.png)

Perform the test specimen in one by one using the testing machine Pull Universal Testing Machine (UTM) with a capacity of 500 kN. From 7 Specimens tested worked well as 5 specimen, while the two specimen failure due to a slip at the end of the specimen clamps.

Although there were 2 Specimens that have failed, but still meet the requirements of the amount due has been more than 3 Specimen and odd number. Document the testing process is shown in Figure 2.

![Figure 2. Process Pull test specimen CFRP (Astawa, M.D, at al, 2015)](image2.png)

Pull powerful look of of CFRP Specimens from laboratory test results Pull melting an average of $f_y = 3073.60$ N / mm², the increase of the standard manufacturer quite significant a value of $f_y = 2520$ N / mm². Thus it can be concluded that the CFRP is used in the field is very strong because it has a capacity above from the analysis that has been done.

What is lacking is disqualify strain ($\varepsilon$) that only reached an average of 4.614% is still below 9.00% according to the provisions of ASTM 615-2000.

Near-Surface-Mounted Fiber-Reinforced Polymer Reinforcements for Flexural Strengthening of Concrete Structures.

The use of Near Surface Mounted FRP reinforcement is currently emerging as a promising strengthening technique and a valid alternative to externally bonded FRP reinforcement for increasing the flexural strength of reinforced concrete members (Raafat EI-Hacha, Sami H, 2004). Rizkalla. The structural perfonnance of reinforced concrete beams strengthened in flexure with NSM FRP reinforcement was examined and compared with beams strengthened with externally bonded FRP reinforcement. The behavior prior to and after cracking, ultimate carrying capacity, and modes of failure of all tested beams are discussed.
in this paper. The variables investigated were the type of fibers, including carbon fiber-reinforced polymer (CFRP) and glass fiber-reinforced polymer (GFRP) thermoplastic, and the configuration of the FRP reinforcement, including reinforcing bars and strips. The effectiveness of NSM FRP reinforcing bars and strips was examined and compared with externally bonded FRP strips using the same material and axial stiffness. The findings of this research provide data for the design guidelines currently under consideration by ACI Committee 440 for the NSM FRP strengthening technique.

Test specimens and setup A total of eight, simply supported, 2.7 m (9 ft) long, concrete T-beams were constructed and tested under a monotonically increasing concentrated load applied at midspan of the beam. The test setup of a T-beam specimen is shown in Figure 5.

![Figure 5. Test setup, beam details, and instrumentation of beam specimens (Hacha & Sami, 2004)](image)

Test matrix One beam was tested without strengthening (BO) and served as the control specimen for comparison purposes. Four beams (B 1, B2, B3, and B4) were strengthened with different NSM FRP systems using CFRP reinforcing bars, two types of CFRP strips, and thermoplastic GFRP strips. Three beams (B2a, B2b, and B4a) were strengthened with different externally bonded CFRP and GFRP strips. A summary of these beams is given in Table 2.

![Table 2: Test matrix for T-beam specimens](image)

Installation of the NSM FRP reinforcing bars and strips begins by making a series of grooves with specified dimensions cut into the concrete cover in the longitudinal direction at the tension side of the beam specimens. A special concrete saw with a diamond blade was used to cut the grooves with the dimensions shown in Figure 6.
A summary of significant test results describing the flexural behavior of all tested beams is presented in Table 3. The concrete compressive strength when the beams were tested was determined according to ASTM C 39-01, using three standard concrete cylinders and ranged between 48 MPa (6962 psi) for Beams BO, BI, B3, and B4, and 57 MPa (8267 psi) for Beams B2, B2a, B2b, and B4a. Beam BO was tested without strengthening and used as a control specimen for comparison purposes to evaluate the improvement in flexural strength provided by the various NSM and externally bonded FRP reinforcements. The un strengthened control beam failed by crushing of the concrete after yielding of the steel tension reinforcement. Load-midspan deflection of beams strengthened with NSM CFRP reinforcing bar and strips, can be seen in Fig. 8.

Installation method of Wiremesh.

Wiremesh an iron material that is made from plain or threaded wirerod formed sheet with a box of 15 cm x 15 cm long x 2.1 m 5.4m having a thickness of 4-10 mm are used for the casting floor reinforcement (Triyanto, 2016). Wiremesh a material that is also less familiar to people because usually casting Indonesia using begel assembled themselves. For those who understand the building using a wiremesh be an option without a doubt, because wiremesh designed to help speed and simplify development, in terms of strength and efficiency, wiremesh superior to other materials. Suppose the casting use 10mm plain stirrup, because the plain reinforcement quality classification bjtd 24 while wiremesh with quality bjtp 40, so it is better to use wiremesh kekutan. Financially use concrete steel is more expensive than on wiremesh, one meter begel spending concrete steel wiremesh worth 99. 000 being only 50. 000. Judging from the application installation begel require a long time and requires a lot of people, while wiremesh pengaplikasiannya faster,

Figure 8. Load-midspan deflection of beams strengthened with NSM CFRP reinforcing bar and strips (Hacha & Sami, 2004)

Figure 9. Wiremesh installation pattern on concrete floor plate (Trianto, 2016)

Figure 10. Wiremesh Reinforcement on footstool for beams (Trianto, 2016)

Figure 11. Installation joining methods wiremesh (Trianto, 2016)

Figure 12. Installation Connection Details wiremesh (Trianto, 2016)

METODOLOGY

Analysis of Statics Concrete Floor Plate.

Numerical analyzes were performed with Software Analaysis Structure Program (SAP 2000). After creating a modeling plate, then to imput load and property, then its output results can be displayed as follows.
Testing needed in the laboratory are:

1. Tensile Test Wire-mesh, using a piece of wire-mesh material along the 600 mm, then tested for tensile strength (fy) using the UTM test machine. Yield tensile strength test results if successful properly according to the American Standard Testing Materials (ASTM, 2000), will yield curve as follows:

2. Bending test concrete plate with CFRP reinforced, cross-sectional dimensions of plate: thickness 12 cm, width 50 cm, length 100 cm. Reinforcement plate mounted CFRP each second rod towards landscape Lx and Ly. Use 3-point load of \( \geq 22 \text{kN} \) in accordance with the results of the analysis. Schematic drawing as follows:

Reinforced concrete slab bending test Wiremesh M8, cross-sectional dimensions of the same plate with reinforced CFRP plate. Wiremesh reinforced concrete plate configuration as shown below:
RESULTS AND DISCUSSION.
Flexure strength test results.

Flexural strength test performed by following the provisions of JIS A 5335-1987, samples of CFRP reinforced concrete slab and Wiremesh each 3 pieces, by loading a centralized (Uniflexure Load), using a machine press UTM test, carried out gradually with the increase in each stage 2kN up to plates cracked and then collapsed. To measure the deflection, using a dial gauge is installed in the middle of the span, and log machine through reading tool UPM Transducer. Evaluation of the results of the bending test, taken the average value of all the test results, the evaluation includes bending strength and deflection. Data flexural strength test results are listed in Table 4.

Table 3. The test results in the laboratory.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Ultimate Loads (kN)</th>
<th>Crack Loads (kN)</th>
<th>Average loads (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFRP</td>
<td>20.40</td>
<td>17.50</td>
<td>19.72</td>
</tr>
<tr>
<td>Wiremesh</td>
<td>20.70</td>
<td>20.70</td>
<td>20.70</td>
</tr>
<tr>
<td></td>
<td>30.10</td>
<td>16.70</td>
<td>21.40</td>
</tr>
<tr>
<td></td>
<td>29.50</td>
<td>18.00</td>
<td>30.00</td>
</tr>
<tr>
<td></td>
<td>30.40</td>
<td>17.80</td>
<td>23.20</td>
</tr>
</tbody>
</table>

Relations load and deflection of the CFRP concrete slab can be seen in the following table 4.

Table 4. Load-deflection relationship on Plate with CFRP Reinforced.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Crack Loads (kN)</th>
<th>Ultimate Loads (kN)</th>
<th>Deflection (mm)</th>
<th>Ductility</th>
<th>Ductility Ductility</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFRP</td>
<td>17.17</td>
<td>20.01</td>
<td>1.56</td>
<td>6.78</td>
<td>3.06</td>
</tr>
<tr>
<td>Wiremesh</td>
<td>20.11</td>
<td>22.86</td>
<td>4.06</td>
<td>10.00</td>
<td>2.46</td>
</tr>
<tr>
<td>Average</td>
<td>19.19</td>
<td>21.06</td>
<td>4.28</td>
<td>8.00</td>
<td>2.60</td>
</tr>
</tbody>
</table>

Dial gauge results of the reading bending test CFRP reinforced concrete slab, successively initial fractured, specimen 1 at load 17.17 kN with a deflection of 1.56 mm, the specimen 2 at load 20.11 kN with a deflection of 4.06 mm and in specimen 3 at load 20.31 kN with a deflection of 7.23 mm. Reaches maximum load and deflection in succession, the specimen 1 by 20.01 kN with a deflection of 6.78 mm, the specimen 2 at 22.86 kN with a deflection of 10 mm and specimens 3 at 20.31 kN with a deflection of 7.23 mm (see table 4).

The following are the load-deflection curve of the specimen CFRP reinforced concrete slab, in figure 21.

Figure 21. Load-deflection curve of the specimen CFRP reinforced concrete slab

Furthermore, the relationship load and deflection concrete plate with Wiremesh reinforced, shown in Table 5 below.

Table 5. Load-deflection relationship on plate with Wiremesh Reinforced.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Crack Loads (kN)</th>
<th>Ultimate Loads (kN)</th>
<th>Deflection (mm)</th>
<th>Ductility</th>
<th>Ductility Ductility</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFRP</td>
<td>16.38</td>
<td>29.53</td>
<td>3.61</td>
<td>11.11</td>
<td>3.08</td>
</tr>
<tr>
<td>Wiremesh</td>
<td>17.66</td>
<td>28.94</td>
<td>2.78</td>
<td>7.78</td>
<td>2.80</td>
</tr>
<tr>
<td>Average</td>
<td>17.17</td>
<td>29.43</td>
<td>2.96</td>
<td>8.89</td>
<td>3.11</td>
</tr>
</tbody>
</table>

The relationship Curve of load-deflection bending test results wiremesh reinforced concrete slab can be seen in Figure 22. Initial cracks of 3 in succession specimens, for specimen 1 at load 16.38 kN with a deflection of 3.61 mm, the specimen 2 at the load 17.66 kN with a deflection of 2.78 mm and specimens 3 at load 17,46 kN with a deflection of 2.50 mm. Reaches maximum load respectively, specimen 1 at load 29.53 kN with a deflection of 11.11 mm, the specimen 2 at load 28.94 kN with a deflection of 7.78 mm and specimens 3 at load 29.82 kN with a deflection of 7.78 mm.
DISCUSSION

Behavior and flexural capacity of reinforced concrete slab with CFRP less effective, because the ultimate load is significantly lower than planned expenses in the amount of 22.86 kN. CFRP experiencing first concrete slab crack of 19.19 kN, ultimate load of 21.06 kN, the ultimate moment of 5.69 KNm, deflection 2.60 mm and a flexural strength of 3.51 MPa.

The use of CFRP plates as external reinforcement on concrete without steel reinforcement plate is less effective, because the ultimate load that occurs fell by 28.44% against the concrete slab wiremesh. The decline also occurred on a deflection by 13.11%, amounting to 28.44% ultimate moments and bending strength of 28.44%.

That's because the debonding failure or release of the bond between the concrete with CFRP to CFRP not work optimally as a composite structure. But the installation of CFRP on a plate can inhibit the first crack as evidenced by the increasing burden of 11.76% first crack at Wiremesh plate.

Behavior and flexural capacity of reinforced concrete slab WIREMESH good enough, it can be seen with increasing load on the ultimate load that is equal to 22.86 kN planned. Wiremesh experiencing first concrete slab crack of 17.17 kN, ultimate load of 29.43 kN, the ultimate moment of 7.95 KNm, a deflection of 3.00 mm and a flexural strength of 4.91 MPa.

CONCLUSION

After analysis and discussion, it can be deduced that that the results of laboratory research menunjkaan reinforced concrete plate WIREMESH better results compared with CFRP plate reinforced concrete. Thus the alternative choice as the best reinforcement concrete slab between two options, CFRP and wiremesh, is a reinforced concrete plate Wiremesh.

REFERENCES

alternative Reinforcement Substitution Bending on Concrete Structures " Presiding The Research Month LPPM-UPN "Veteran" East Java, Surabaya, December 8, 2015


15. Reference of Sika’s, “Strengthening and Repair Projects” whole project from the year 2000-2013.


USE OF PLASTIC WASTE HIGH DENSITY POLYETHYLENE (HDPE) IN CAMPUS AND BOTTOM ASH WITH CARBONIZATION FOR MAKING FRIENDLY ENVIRONMENT BRIQUETTES

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ABSTRACT

A common issue is the treatment of plastic waste that led to the waste disposable system without prior process or processes plastic into goods that have more value and useful. Research must be done to change the form of waste plastic and waste coal bottom ash that are no longer used and unceremoniously dumped after the combustion process, into a renewable alternative fuel that is briquette.

This study aims to utilize plastic waste and bottom ash for alternative fuels in the form of briquettes as well as determine the best composition between plastic and bottom ash to produce briquettes with a calorific value best.

Briquetting done using HDPE plastic which has been carbonized and bottom ash with adhesive molasses. Both material and sieved to 30 mesh size was added molasses and printed by means of press hidrolic. Briquettes are then oven-dried for 10 hours at a temperature of 105ºc for removal of moisture. Using a mixture ratio of 1: 1 to 1: 4. Analysis was conducted on the analysis of heat, compressive strength, moisture content and ash content. Of the 16 analyzes conducted on the briquettes obtained the best results with a mixture of 1: 4 with a calorific value of 5352.6 cal / g, the water content of 15.56%, 13.58% ash content and the strength of the pressure 58 kg / cm2.

Keywords: HDPE plastic waste, bottom ash, briquettes

PRELIMINARY

Plastics are generally circulating in the community in the form of plastic bags made from recycled plastic, which is not certain of the materials used and the obvious contain harmful materials for the environment and an element B3 (Hazardous Materials Toxic) therein. Burning of plastic waste is not a primary solution because in addition to cause pollution of the emissions produced, the result of burnt plastic waste also has an impact on the environment.

Hard plastic waste is broken down by soil and it took hundreds - hundreds of years to decompose the main focus in this study. On the other hand the waste from the combustion of coal is also a separate issue whose existence participate and contribute in polluting the environment.

Coal is often used in steam power plant (power plant). Of the various industries that have been using coal in the production process, there are many who produces fly ash and bottom ash.

Waste from coal burning is divided into two fly ash (fly ash) and bottom ash (ash results) are burning that have a heavier than fly ash and shaped like chunks. Bottom ash when disposed kelilingkungan also be dangerous because sooner or later will be formed of methane (CH4), which at any time - can ignite or explode by itself (self burning and exploding self). On the other hand, if it will be used in the cement factory will change the design of the feeder, so that the cement plant was not keen to take advantage of the bottom ash.

(Wong 2007)

A common issue is the treatment of plastic waste that led to the waste disposable system without prior process or processes plastic into goods that have more value and useful. Therefore research must be done to change the form of waste plastic and waste coal bottom ash that are no longer used and unceremoniously dumped after the combustion process, into a renewable alternative fuel that is briquette.

RESEARCH METHODOLOGY

This study will discuss the influence of raw material is waste coal bottom ash and plastic types of HDPE (high density polyethylene) on water content, ash content, heating value, and strong press generated by the briquettes.

Materials and Equipment

Materials used bottom ash from the paper mill. HDPE plastic used were obtained from plastic waste special black crackle obtained from garbage collectors. For adhesives used molasses is obtained from sugar mill waste.

Equipment used furnace, oven, shiever, hydraulic press, brass, porcelain bowls, grinding, scissors.

Method

Briquettes made from HDPE plastic bottom ash and divided into two experiments, namely the preparatory stage and the main experiment. The
preparation phase cutting into small plastic and then put into the furnace for 60 minutes at 450 ° C. Plastic inserted into the desiccator, wait until the temperature drops plastic (room temperature), plastic crushed until dissolved and then sieved to 30 mesh sieve. Mashing up crushed bottom ash ago sieved to 30 mesh sieve

For the main experiment prepare the mold of metal pipe with a diameter of 5 cm and a height of 5 cm. Mixing plastic and bottom ash with molasses.

Incorporating a mixture of plastic, bottom ash, and adhesives that have been blended into a mold. The mixture was molded in the mold using a tool hydraulic press to form a jack. Issued briquettes from the mold and then placed on a baking sheet. To oven with a temperature of 105 ° C for 10 hours to remove the water content in the briquettes. After completion of roasted briquettes cooled in a desiccator.

RESULTS AND DISCUSSION

From the preliminary analysis that we can know this hypothesis that the addition of more and more plastic, the water content will be smaller. Likewise, the more the addition of bottom ash increases the water content this is because plastic has little water element of the bottom ash

Table 1. Effect of Ratio of Bottom Ash and HDPE Plastics Against Moisture (In %)

<table>
<thead>
<tr>
<th>Bottom Ash</th>
<th>HDPE 1</th>
<th>HDPE 2</th>
<th>HDPE 3</th>
<th>HDPE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.94</td>
<td>14.58</td>
<td>14.13</td>
<td>21.3</td>
</tr>
<tr>
<td>2</td>
<td>15.28</td>
<td>16.11</td>
<td>17.2</td>
<td>18.61</td>
</tr>
<tr>
<td>3</td>
<td>14.34</td>
<td>14.74</td>
<td>15.13</td>
<td>15.3</td>
</tr>
<tr>
<td>4</td>
<td>13.58</td>
<td>14.12</td>
<td>14.42</td>
<td>16.21</td>
</tr>
</tbody>
</table>

From the table it shows the value indicated by the low water levels briquettes by treatment with a mixture of 1: 4, 2: 2 and 2: 3 amounting to 15%.

Figure 1. Effect of Ratio of Bottom Ash and HDPE Plastics Against Moisture

As for the highest water levels indicated by briquettes with the treatment of a mixture of 1: 1 in the amount of 15.81% and a mixture of 4: 3 is equal to 15.65%.

This proves briquettes are made from raw materials with a mixture of HDPE plastic mostly contain water levels were very low at only 15% compared with a briquette material raw bottom ash mixtures mostly contain the most water content of up to 15.81% in the mixture 1:1 and a water content of up to 15.65% in a mixture of 4:1.

According to ISO 4931 in 2010 on Coal Briquette, Classification and Testing Methods stated that the standard for coal briquette without carbonization process both class A and class B of ≤ 17%. In this study the whole briquettes produced included in the standard set for the entire research briquettes figures show the range of 15% which is certainly below the standard set that is 17% on each briquettes produced.

Ash content analysis was conducted to determine the number of parts that do not burn after the complete combustion. Higher ash levels can complicate the process of operation and maintenance of combustion.

Table 2. Effect Ratio of Bottom Ash and HDPE Plastics Against Abu Kadar (In %)

<table>
<thead>
<tr>
<th>Bottom Ash</th>
<th>Plastic HDPE 1</th>
<th>Plastic HDPE 2</th>
<th>Plastic HDPE 3</th>
<th>Plastic HDPE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.94</td>
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</tr>
<tr>
<td>4</td>
<td>13.58</td>
<td>14.12</td>
<td>14.42</td>
<td>16.21</td>
</tr>
</tbody>
</table>

Based on the analysis and the calculation is done, table 2 it can be shown that the ash content in the briquettes is highest in a mixture of 1: 4 ie by 21.3%. While most low ash content contained in a mixture of 4: 1 that is equal to 13.58%.

Figure 2. Effect of Ratio of Bottom Ash and HDPE Plastics Against Ash Content

From Figure 2, shows that the briquettes with a mixture of plastic raw materials HDPE has the most highest among the ash content briquettes - briquettes others, while briquette with bottom ash
mixture of raw materials at the most have the least ash content. The difference between the ash content briquettes with HDPE plastic raw materials at most with the use of briquettes raw material bottom ash at most up to 7.72%.

Analysis of ash content in the briquettes produced average - average meets the standards set in the amount of ≤ 20% on each briquette. But to briquettes with a mixed composition of raw materials HDPE versus bottom ash on a ratio of 1: 4 that exceeds the standards set by the ash content of 21.3%. This is because many quantity of raw materials from HDPE plastic from the bottom ash briquettes while the quantity of raw material mixture of bottom ash has more ash content far better and meet the standards set. It also proves that the ash content in HDPE plastic are more than the bottom ash.

Calorific value analysis was conducted to determine the calorific value contained in each product eco briquettes. The calorific value is the value that states the amount of heat contained in the fuel. The calorific value is the main quality for a cheap fuel. Calorific value measurement is done using a Bomb Calorimeter. Calorific values determine the quality briquettes. The higher the calorific value, the better the quality briquettes produced.

Table 3. Effect of Ratio of Bottom Ash and Calorific Values Against Plastic HDPE (Cal / g)

<table>
<thead>
<tr>
<th>Bottom Ash</th>
<th>1:2</th>
<th>2:1</th>
<th>1:4</th>
<th>4:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4820.6</td>
<td>5287.3</td>
<td>4909.2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5245.9</td>
<td>5027.5</td>
<td>4842.6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5289.8</td>
<td>5160.6</td>
<td>5110.5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5352.6</td>
<td>5295.9</td>
<td>4850.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 shows that of the 16 treated to a mixture of raw material briquettes which have the highest calorific value contained in a mixture of 4: 1 that is equal to 5352.6 cal / g. As for the raw material mixture of briquettes with a calorific value was lowest for the 1: 1 mixture which only amounted to 4820.6 cal / g. This suggests that the high calorific value contained in briquettes with bottom ash mixture of raw materials at the most. Can be found also to briquettes with a mixture of bottom ash feedstock most have high calorific value compared to briquettes with a mixture of HDPE plastic raw material most.

Figure 3 shows the heating value generated from this study entry in 4931-2010 SNI provisions on the classification, quality requirements, and testing methods. From Figure 4-3 it can be shown that the calorific value contained in briquettes research results are divided in two categories: for the first category with a calorific value of 4000 cal / g up to 5000 cal / g in the category of class B, while for category A class with a calorific between 5000 - 6000 in the category of class A. To briquettes with raw material mixture in the ratio 1: 1, 1: 2, 1: 4, 2: 2, 2: 4, 3: 3, and 4: 4 in the category for class B has a calorific value of less than 5000 cal / g. For comparison briquettes with other raw materials fall into the category of class A with a calorific value of more than 5000 cal / g. This is due briquettes into the category of class B contained a mixture of HDPE plastic raw materials more calorific values slightly.

In contrast to briquettes are included in A class category are the raw material ratio of bottom ash more than HDPE calorific values more than 5000 cal / g. Briquettes are included in the category of class A, among others, the briquette with a mixture of raw material ratio of 1: 3, 2: 1, 2: 3, 3: 1, 3: 2, 3: 4, 4: 2, 4: 2 and 4: 3.

Analysis conducted to determine the compressive strength of briquettes in weight-bearing strength. These expenses are expressed in certain pressure. The compressive strength you need to know as it pertains by way of the transport and storage of briquettes. Product briquette the compressive strength is low susceptible to cracking or breaking during transportation and storage. The load on the scale reading apparatus marshall compression machine.
Table 4. Effect of Ratio of Bottom Ash and HDPE Plastic Compressive Strength Against (G / cm²)

<table>
<thead>
<tr>
<th>Bottom ash</th>
<th>Plastic HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>3</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>58</td>
</tr>
</tbody>
</table>

Table 4 shows that the compressive strength highest at 58 kg / cm² contained in briquettes with a ratio of 4:1 with the mixture of raw materials bottom ash at most, whereas for briquette with the compressive strength of the most low of 17 kg / cm² contained in briquettes with a ratio of 1:4 with a mixture of HDPE plastic raw material most many.

This shows that the briquettes with a mixture of raw materials at the most bottom ash has a high compressive strength value while the briquettes with a mixture of HDPE plastic raw materials at most have a low compressive strength value because the shape and structure of these two very different materials. Bottom ash has a shape and a hard structure, whereas HDPE plastic which has been carbonized shape and structure slightly softer, shaped like pasta and a little fragile.

Figure 4. Effect of Ratio of Bottom Ash and HDPE Plastic Compressive Strength Against (G / cm²)

For the briquettes from the analysis that the value of compressive strength approaching SNI is set at a ratio of 3:2 and 4:2 also uses a mixture of bottom ash raw materials more than the use of HDPE plastic. It can be shown that the HDPE plastic raw materials may affect the value of compressive strength in the briquette analysis results can decrease the compressive strength.

CONCLUSION

Based on the research that has been done can be concluded as follows:

1. The results of the characteristics of each - each briquette treatment composition shows that increasing the proportion of the use of bottom ash as a raw material briquette mixture can increase the heat. Moisture content and ash content in accordance with the provisions set.

2. Briquette of 16 treatment contained in the bottom ash treatment comparison: HDPE 4:1 with a calorific value of 5352.6 cal / g, the lowest ash content, amounting to 13.58% and 15.56% water content.

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EFFECT OF FLOW RATES AND FILTER MEDIA IN REMOVING NATURAL ORGANIC MATTER AS DETECTED BY USING FLUORESCENCE EXCITATION EMISSION MATRICES

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ABSTRACT

Natural organic matter (NOM) in water is mixture compound of organic, which is derived from animal and dead plant, microorganism and degradation by-products. NOM has various quantity and composition, however has low concentration in water and hardly detected and classified. Water treatment processes have different ability to remove NOM, it depends on the characteristic of NOM. This research aims to characterize NOM in laboratory scale of water treatment under various flow rate and filter media by using spectroscopy and fluorescence analysis. Source water contains aromatic and hydrophobic compound, with TOC 3.3 mg/L and SUVA 2.17 L/mg.m. Fluorescence method identified that source water contain of humic acid-like 52% and fulvic acid-like 26%. Coagulation-filtration with flow rate 30 L/hour and activated carbon could removed TOC 55%, UV254 45%, and humic acid-like and fulvic acid-like around 35-38%.

Keywords: natural organic matter, coagulation-filtration, filter media, flow rate.

INTRODUCTION

Natural organic matter (NOM) is one of the parameter that affect water quality during treatment process (Matilainen et al., 2010). Natural organic matter, especially in waters composed of a group of organic carbon derived from plant or aquatic biota as well as from organic materials derived from industrial and domestic waste. NOM is responsible for the formation of disinfection by-products, causing the re-growth of biology in the water distribution system, the main contribution of NOM is causing the problem of color, taste and smell, and also transport of inorganic and organic pollutants (Kim, et al., 2005). Coagulation and filtration are two common processes carried out on water treatment, coagulation is mixing water and coagulant and thus forming floc that can precipitate, and formed floc will be filtered on the filtration process for reducing turbidity. NOM could be removed in the process of coagulation and flocculation is through the mechanism of formation of aggregates floc. Filtration is the cleaning of solid particles from a fluid by passing the filtration medium, on which solids will precipitate out. Coagulation process is determined by the dose and the type of coagulant, while filtering is strongly influenced by the type of filter media (Edzwald, 2011; Matilainen et al., 2005).

Spectrophotometric can be used to analyze the concentration of a substance in a solution based on the absorbance of the color of the solution at a particular wavelength. Some spectrophotometric method, for example: dissolved organic carbon, or TOC, measure all the dissolved organic material without knowing what kind of organic material contained in water (APHA, 2005), spectroscopic methods UV/Vis UV254 provides information on the organic matter content of aromatic carbon. SUVA value provides an indication of the type of organic material that is dominant in water. SUVA value > 4 indicates the composition of the aqueous and organic humic with high molecular weight. SUVA value 2-4 indicates a mixture of organic material and non-humus humus, while SUVA value < 2 indicates a non-humic dominant components (Edzwald, 2011). The other spectrophotometric method is using fluorescence. Fluorescence is the emission of light radiation by a material after excited by the high-energy light beam. Fluorescence is a process of moving the energy levels of the excited atoms to the state to a stable state, and this process takes approximately 1 nano seconds (Leenheer et al., 2000).

Therefore, this study aimed to characterize the type of natural organic matter which successfully removed in the process of coagulation and filtration under various filter media and flow rates through fluorescence analysis.

METHODOLOGY

The study focused on characterization of NOM in source water through water treatment unit, including coagulation with coagulant FeCl3, sedimentation, and filtration with activated carbon or silica sand media, and detected by using spectroscopic methods. Experiment was conducted under continues process with flow rates 30 L/hr or 60 L/hr. Characterization of NOM using the spectrophotometric method, including NPDOC analysis, analysis of UV at a wavelength of 254 nm or UV254, calculation SUVA (Edzwald 2011 and Her, et al., 2002). Characterization of NOM by using Fluorescence Excitation Emission
Matrices (FEEMs) Perkin Elmers types LS55. The quantification of fluorescence analysis will be solved by Fluorescence Regional Integration (FRI) method, in order to determine the area of fluorescence (Chen et al., 2003).

RESULT AND DISCUSSION

Water Quality Analysis
Sample was taken from Jagir River on June 2016. Firstly, sample was analyzed to observe the initial water quality of the Jagir River. The optimum dosage of FeCl₃ coagulant 200 mg/L, were determined based on the dosage which is obtained from 1st year of previous study. Table 1 shows Jagir River water quality data prior to coagulation-filtration. Jagir River has a neutral pH, low turbidity, it is probably due to sample was taken during the dry season. Low alkalinity will affect the dose of coagulant. Low value of organic pollutants, which is indicated by dissolved oxygen (DO) and biological oxygen demand (BOD), is probably due to effect of dry season and sun exposure resulting in the degradation of organic matter (Delpla et al., 2009).

Table 1. Water quality of jagir river before treatment process

<table>
<thead>
<tr>
<th>Water quality parameter</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.8</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>45</td>
</tr>
<tr>
<td>Alkalinity (mg/L)</td>
<td>60</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>3.0</td>
</tr>
<tr>
<td>TOC (mg/L)</td>
<td>3.3</td>
</tr>
<tr>
<td>UV₂₅₄ (cm⁻¹)</td>
<td>0.072</td>
</tr>
<tr>
<td>SUVA (L/mg.m)</td>
<td>2.17</td>
</tr>
</tbody>
</table>

According to Edzwald (2011), the value of SUVA in Jagir River categorized as non-mixture of humic and humic, also a mixture of aliphatic and aromatic components as well as a mixture of hydrophobic and hydrophilic components. The mixture of organic material components shows the influence of natural organic matter derived from domestic sewage or industrial wastewater (effluent organic matter) and terrestrial (allochtonous) as well as organic materials resulting from the microorganism in water (autochtonous).

Effect of Filter Media and Contact Time to Removal of Natural Organic Matter
Coagulation with FeCl₃ 200 mg/L remove NOM in terms of total organic carbon (TOC), UV₂₅₄ to indicate aromaticity of organic matter, and in terms of SUVA value to represent the polarity of NOM. Based on Figure 1., Figure 2. and Figure 3. which shows the removal of NOM under various flow rates and filter media, which is shown as TOC, UV₂₅₄ and SUVA. Each parameter has the ability to detect natural organic matter. TOC provides information on the quantity of organic matter without knowing the type or quality of the organic material.

Based on Figure 1, coagulation could removed less than 60% of TOC under activated carbon media with flow rates 30 L/h. It shows higher removal than using silica sand, about 35%. This means that more than 40% NOM still remained in the sample, which is probably a type of non-aromatic, aliphatic and smaller molecular weight, because coagulant FeCl₃ with activated carbon media has not been able to remove those kind of components. This is also supported by Figure 2, which indicates removal of aromatic components around 45% with active carbon media and flow rates 30 L/hr, and 35% removal of TOC with silica sand and flow rate 30 L/hr.

Figure 1. TOC removal under different flow rates and filter media.

Figure 2. Removal of UV₂₅₄ under various flow rates and filter media.

UV₂₅₄ has lower removal than TOC, it seems that the filtration process is more effective for non-aromatic components. UV₂₅₄ shows aromatic components are easily removed by coagulation because the aromatic components generally have
large molecular weight, which is easily tied or formed aggregates with coagulant. TOC detected all organic components that could not be identified its properties. But through filtration process, non-aromatic components shows better removal, it means that filtration with activated carbon has a good capability to remove non-aromatic components.

Figure 3. Removal of organic carbon in terms of SUVA value under various flow rates and filter media.

Based on Figure 3, removal of SUVA value, which shows less than 10%, indicates that the organic component is dominated by hydrophilic and those components are quite difficult to be removed or bounded by coagulant or by both filter media. Overall, the composition of organic matter varies greatly, therefore its removal also vary. It corresponds to the mechanisms in removing of organic matter through coagulation and filtration processes will be different for certain types of NOM contained in water.

Aromatic properties and components that have high molecular weight generally excluded through the coagulation process by sweep flocculation mechanism, whereas if the formed aggregates are monomers or intermediate polymers, the mechanisms is complexation, adsorption, or charge neutralization co-precipitation. The formed floc during coagulation have different properties or characteristics, including size, structure and strength (Edzwald, 2011). While in the process of filtration, activated carbon media will filter out fine particles, which couldn’t settle simultaneously, then activated carbon will adsorb NOM that has been bonded in the formed floc.

Effect of Filter Media and Contact Time to Removal the Fluorescence of Natural Organic Matter Based on its Region

This part focused on the type of organic matter based on the classification of their region, as shown in Figure 4. Fluorescence Regional Integration techniques (FRI) is used to determine the extent of each region, in order to obtain the effectiveness of the removal of NOM fluorescence based on its flow rates and types of filter media, as described in Figure 5 and Table 2. Coagulation under 200 mg/L FeCl₃ and activated carbon or silica sand have removed fluorescence of NOM succesfully such as those obtained by FEEMs with the FRI method. The organic fractions, which is represented by all regions, could not be removed under short contact time, t=10 minutes. It is probably due to the formed floc could not bind NOM and filter media less capability to adsorb NOM under a very short time. Some research found that NOM with hydrophilic properties will be difficult to be bound by the coagulant.

Figure 4. Classification of the NOM region based on its fluorescence properties.

Table 2. Excitation and emission of each NOM region

<table>
<thead>
<tr>
<th>Region</th>
<th>Excitation (nm)</th>
<th>Emission (nm)</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&lt; 250</td>
<td>&lt; 330</td>
<td>Aromatic Protein 1</td>
</tr>
<tr>
<td>II</td>
<td>&lt; 250</td>
<td>330 - 380</td>
<td>Aromatic Protein 2</td>
</tr>
<tr>
<td>III</td>
<td>&lt; 250</td>
<td>380 - 550</td>
<td>Fulvic Acid-Like</td>
</tr>
<tr>
<td>IV</td>
<td>250 - 400</td>
<td>&lt; 380</td>
<td>Soluble Microbial Products</td>
</tr>
<tr>
<td>V</td>
<td>250 - 400</td>
<td>380 - 550</td>
<td>Humic Acid-Like</td>
</tr>
</tbody>
</table>

It seems that aliphatic hydrophilic component is mostly dominant in Jagir River. Removal of Region 1 aromatic protein 1 (Figure 5a), Region 2 aromatic protein 2 (Figure 5b) and Region 4 soluble microbial products (Figure 5d) seems
difficult to be removed under flow rates 60 L/h and silica sand or activated carbon, though under flow rates to 30 L/hr with activated carbon. Coagulation and filtration processes under various flow rates and filter media filters has capability around less than 25% for removing Region 1, Region 2 and Region 4. Region 3 fulvic acid-like could removed about 35% under both media and the same flow rates (Figure 5c). While Region 5 humic acid-like obtained 40% removal with activated carbon media and reached 35% by silica sand media (Figure 5e). Activated carbon demonstrates presents more better performance than than silica sand, probably due to activated carbon has larger surface area than the silica sand (Velten et al., 2011). It is consistent with the previous studies (Chow et al., 2009; Edzwald, 2011).

It also has been observed that the effectiveness of FeCl₃ as coagulant has an important role before filtration process. FeCl₃ coagulant performed in wider pH range although the optimum pH is at pH of 4.5-6. In the pH range 5-7, iron (III) has a lower minimum solubility level than alum, it resulted in the formation of more hydroxide under low coagulant doses. Therefore, hydrolysis of FeCl₃ coagulant will produce more hydrolyzed products (Chow et al., 2009; Edzwald, 2011). However, at low doses, humic as anion will bind to cationic coagulant, then formed floc become increasingly congested. Further, increasing dose FeCl₃ will result in an aggregate acid hydrolysis products Fe humus to cause competition between the components of humic during the destabilization process of colloids. Additionally, since FeCl₃ has higher molecular weight, therefore, under the same dose, FeCl₃ with other coagulant dose (e.g., alum) will produce 2.8 times more hydroxide products than alum hydroxide. Overall, the combination of coagulation and filtration process has removed NOM about 25% to 35% (Figure 5f). Lower flow rates, 30 L/hr, and activated carbon media produces optimum removal as compared with higher flow rates.
CONCLUSION

Water quality analysis indicates that River Jagir, Surabaya is mainly composed of aromatic components and slightly hydrophobic, with TOC 3.3 mg/L, SUVA value 2.17 L/mg.m FEEMs measurement and FRI analysis classified Jagir River into five types of organic components, namely the aromatic proteins 1 and 2 (5%), soluble microbial products (15%), fulvic acid-like (35%), and humic acid-like (45%). The process of coagulation and filtration with flow rate 30 L/h removed 50% TOC with activated carbon media and 35% with silica sand media. It is also able to remove aromatic organic or UV$_{254}$ up to 40% with activated carbon media and 35% with silica sand media.5. However, coagulation-filtration has less performance in removing hydrophilic organic components, as indicated by removal of SUVA.

Figure 5. Removal of NOM in each region under various flow rates and filter media based on fluorescence analysis
about less than 10%. Coagulation and filtration with flow rates 30 L/h shows higher removal of fluorescence organic matter, about 35%, as compared with flow rates of 60 L/hr (25%). Substance humic fluorescence, including humic acid and fulvic acid-like-like, is more easily removed by coagulation. Based on HPSEC analysis, biopolymers showed high removal, which indicates that the fluorescence of humic substances is a type of bioplymer.

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CONSUMPTION SALT FROM CRUDE SOLAR SALT

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ABSTRACT

Crude solar salt is produced by natural evaporation of sea water without washing process. Four different samples of crude solar salt were collected from different sites of East Java Indonesia. The four samples contain sodium chloride (NaCl) : 89.25% ; 82.32% ; 83.65% and 88.34 % (dry base) and substantial impurities like magnesium, calcium, sulfate and others. Those crude solar salt quality is still below of the Indonesian National Standard (SNI) for human salt’s consumption sodium chloride content is 94.7 % (dry base). Consumption salt can produced by two steps processes including washing process and evaporation (crystallization). The washing process can decrease of salt impurities like sand, clay, magnesium, calcium and potassium and evaporation process or crystallization also can decrease of salt impurities like magnesium, calcium and potassium. Base on the research, the first step by washing process produced salt contained sodium chloride (NaCl) : 97.85 %, 96.78 %, 94.85 % and 98.14 % (dry base) and The evaporation process produced salt contained sodium chloride (NaCl) : 99.05 %, 98.78 %, 97.75 % and 99.21 % (dry base). The two steps processes can producing salt contained sodium chloride (NaCl) : 99.05% - 99.21 %. The quality of salt produced by application of washing process can reached of the Indonesian National Standard (SNI) for human salt’s consumption.

Key word : crude solar salt, washing, partial evaporation.

Introduction

Crude solar salt is a salt produced by natural evaporation of sea water without washing process. The quality of crude solar salt produced has different quality influenced by seawater quality as a raw material and processing technology application. Four samples of crude solar salt were collected from different sites of East Java Indonesia. The four samples contain sodium chloride (NaCl) : 89.25% ; 82.32% ; 83.65% and 88.34 % (dry base) and substantial impurities like magnesium (Mg\textsuperscript{2+}), sulfate (SO\textsubscript{4}\textsuperscript{2-}), and calcium (Ca\textsuperscript{2+}). Those crude solar salt quality is still below of the Indonesian National Standard (SNI) for human salt’s consumption sodium chloride content is 94.7 % (dry base) and industrial salt is 98 – 99.2 % (dry base)

Improving The Quality of Salt Methods

There are several methods for improving the quality of salt included physical and chemical methods, physical method is a method for improving the quality of salt without addition of chemicals such as washing and evaporation (crystallization) methods and chemical method is added chemicals such as sodium carbonate (Na\textsubscript{2}CO\textsubscript{3}), sodium hydroxide (NaOH), barium chloride (BaCl\textsubscript{2}), calcium hydroxide (Ca(OH)\textsubscript{2}), calcium chloride (CaCl\textsubscript{2}) and other.

Application of washing (leaching) method on improving the quality of salt can eliminate insoluble materials such as dust, soil and sand also soluble materials such as magnesium, calcium and sulfate, but difficult for material inner of salt because salt diameter too large, the washing process more effective if the size of salt smaller about 100-200 mesh. Evaporation (crystallization) process can eliminate soluble materials such as magnesium, sulfate, calcium and other because crystal formation.

MATERIALS AND METHODS

There are 4 (four) types of solar salt were used as research material in this research that the salt A, B, C and D with difference qualities. The salts are washed by saturated salt solution and mixing for 15 minutes. The salt is separated by filtration and analyzed the content of sodium chloride and others. The results of washing salt is dissolved by water (360 grams salt per 1 liter of water) and evaporated at 115 C. The evaporating process is stopped if 40% of water has evaporated, salt crystal is separated by filtration and analyzed the content of sodium chloride and others. The Improving quality of solar salt by combining the washing and evaporation methods is presented in the following figure.
RESULTS AND DISCUSSIONS

The chemical composition of crude solar salt that used in this research as raw research material and the effect of washing method on the crude solar salt quality are presented in the following figure 1

Figure 1. Schematic Diagram of Improving quality of solar salt

Figure 1. showed that the washing methods with saturated salt solution increased the sodium chloride (NaCl) concentration of crude solar salt 12.7 % average. The washing (leaching) method can eliminate insoluble and soluble materials in salt. the purity of sodium chloride after washing process could be enhanced up to 94.85-98.15 %, and reached of Indonesian national standard for human salt’s consumption.

CONCLUSION

1. The quality of crude solar salt as research materials has different quality, the four crude solar salt samples has concentration 80-90 % of sodium chloride
2. The washing or leaching method increased the concentration of sodium chloride (NaCl) of crude solar salt 12.7 % average and reached Indonesian national standard for human salt's consumption
3. The evaporation or crystallization method for the first stage evaporation increased the concentration of sodium chloride (NaCl) of crude solar salt 14.22 % average. The purity of sodium chloride could be enhanced up to 97.75 – 99.21 % and reached Indonesian national standard for human salt’s consumption

REFERENCES

ABSTRACT

Traffic congestion has become a major problem in large cities, including the city of Surabaya. The rapid growth of vehicle is not comparable to the growth of existing roads, which often occurs during rush hour morning and afternoon there will be accumulation of vehicles on main roads or arteries in big cities such as Surabaya. To overcome this problem have been many steps taken but not yet get the maximum results, it is characterized by the presence of congestion on some existing arterial roads. The aim of this research is to take an application of geographic information system, which is about to merge technology with existing topographic maps in the city of Surabaya with attribute data such as vehicle speed and traffic volume. The final result obtained is information about the traffic volume, the optimum speed of the vehicle and maximum density of vehicles that can occur on arterial roads in the city of Surabaya. Furthermore it can be concluded from this study that the road Ahmad Yani has the greatest traffic volume value is 129911 pcu / hr, the road of Kenjeran has a maximum speed (Sff) of 43.3 km / hr at optimum conditions, and the density of road is goes to Urip Sumohardjo road with the point 1807 pcu / km when the road are saturated by the traffic.

Keyword: traffic congestion, speed of vehicles, traffic volume, Greenshield methods, Geographic information system

INTRODUCTION

The traffic jams in big cities like Surabaya is already a common problem for people who use the road. Arterial roads both major arteries or arterial grade 1 in the rush-hour is always an impact which is still developed various methods suited to address such problems. There have been many studies that raised the problem of congestion in large cities, both from an economic point in the form of loss of travel time as well as the effects of pollution in the form of noise and fumes spread by the exhaust of motor vehicle fuel.

Methods of solving the traffic congestion on a road section deals with some parameters of the characteristics of the road such as the vehicle speed, traffic flow and density of road. One of the methods developed is a method of Greenshield stating that the linear mathematical relationships, methods of Greensberg stating exponential mathematical relationships and the methods of Underwood stating mathematical relationship is logarithmic.

Vehicles moving on a road section towards the intended location will have a certain vehicle speed with the aim to reach the location with the shortest time. With the traffic light, the speed of these vehicles will increase and decrease in speed is not constant, it is influenced by the length and width of the road and foremost is the existing traffic flow on the road.

The first issue of concern is how to provide a detailed overview of the state of congestion based on the hierarkie of the level density, and with other supporting data like time travel, time of recording, type of vehicle and the road situation was observed in the same time. It will take a very high cost, time and effort recording because it involves surveyors in large numbers in addition to the risk pattern of the recording is not the same among surveyors, in addition to the influence of the connections between the arterial road with one another and the number of premises used as place of business which has the effect of vehicle movements will not be recorded properly.

The primary use of geographic information system is considered to have advantages when compared to the manual method, in which the field measurements were conducted simultaneously on several arterial roads can be replaced with the mapping situation of continuous arterial highways full digitally. Besides, with the attribute data which attached to the spatial data thematic map will give you the full picture of the condition and situation of the roads and this condition is ready for further analysis to the needs of the future.

The aim of this study is to get an overview model of the characteristics of the density of roads in several arterial roads of Surabaya and the results will be mapped as a form of thematic maps with the use of geographic information systems.

METHODOLOGY

This study who required the processing of traffic data is divided in the spatial data and the attribute data. For data attributes required vehicle speed data in units km / hr, the traffic volume data in units pcu / hour, while for spatial data needed basic maps are topographical maps for the area of Surabaya which is divided into several pieces of
maps Indonesia (RBI) with a scale 1: 25.000 which was published in 1999.
Location of the study includes several arterial roads in the city of Surabaya with some selected road is the Ahmad Yani, Diponegoro, Raya Darmo, Urip Sumohardjo, Basuki Rachmat, Tunjungan, Mayjen. Sungkono, Ir.H.Soekarno, Manyar Kertoarjo and Kenjeran street, as shown in Figure 1.

Figure 1. Some of the artery road data in Surabaya City.

Vehicle speed data measured at the morning rush hours are 06.00 to 09.00 with a 15 minute interval recording, as well as measurements on the afternoon rush hour is at 15:00 to 18:00 pm with a 15 minute interval recording.

Traffic volumes data are measured at the same time with the recording speed of the vehicle, during the morning rush hour and the afternoon rush hour at the same time intervals and recording was done simultaneously on several arterial roads that have been selected.

Greenshield formula of mathematical models expressed as equations form that states the relationship between the speed of a vehicle with a road density (equation 1), the equation expressing the relation of traffic volume to the vehicle speed (equation 2), as well as a mathematical equation that states the relationship with the volume of traffic road density (equation 3) (Tamin, 2003):

\[ S = S_{ff} - \frac{S_{ff} \cdot D}{D_{j}} \quad (1) \]
\[ S = S_{j} - \frac{D_{j} \cdot S_{ff}}{S_{ff}} \quad (2) \]
\[ S = S_{ff} \cdot D - S_{ff} \cdot D_{j} \quad (3) \]

Where 
- \( S_{ff} \) is a free flow speed in units km / hr, and
- \( D_{j} \) is the current density saturated in units pcu / km

To find the value of road density (D) used vehicle speed data (S) and the data traffic volume (V) and put in relation the linear regression equation to get the value of SFF and the Dj.

The linier regression equation expresses as : 
\[ y = a + bx \]

Where a and b is the coeisien of linier regression that must be find with the equation (5) and (6):
Results obtained from field measurements on each road artery for subsequent measurement of linear regression and the results for \( \sum x, \sum y, \sum x \cdot y \) dan \( \sum x^2 \) as seen on Table 2, and then calculated the value of SFF and the \( D_j \) for each road arteries that results can be seen in Table 3.

In Table 3. It can be seen that the arterial roads that have the largest \( R \) value is the road of Ahmad Yani with \( R = 0.892 \), while those with the lowest \( R \) value is Urip Sumohardjo roads with \( R = 0.249 \) which indicates that the relationship between the speed of a vehicle with a road density relative low on these roads.

As for the speed chart between relationship with density that is used to find the value of SFF and the \( D_j \) can be seen in Figure 1 to Figure 10. Where these graphs are shown in the movement patterns of the vehicle speed for each density \( D \) value is there.

\[
b = \frac{\sum x \cdot y - \sum x \cdot \sum y}{\sum x^2 - \sum x}
\]
\[
a = \frac{\sum y}{N} - b \cdot \frac{\sum x}{N}
\]

When \( y \) represent \( S \) and \( x \) represent of point \( D \) in the Greenshield models so the value of Sff and \( D_j \) can be calculated from the linier regression.

**RESULT AND DISCUSSION**

<table>
<thead>
<tr>
<th>No</th>
<th>Name of road</th>
<th>( \sum D )</th>
<th>( \sum S )</th>
<th>( \sum D^2 )</th>
<th>( \sum D*S )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mayjen Sungkono</td>
<td>2273</td>
<td>350,2</td>
<td>458051</td>
<td>65877</td>
</tr>
<tr>
<td>2</td>
<td>Ahmad Yani</td>
<td>5062</td>
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<td>2244395</td>
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<td>341,2</td>
<td>771374</td>
<td>84551</td>
</tr>
<tr>
<td>9</td>
<td>Manyar Kertoardjo</td>
<td>2497</td>
<td>346,4</td>
<td>530731</td>
<td>71669</td>
</tr>
<tr>
<td>10</td>
<td>Tunjungan</td>
<td>1671</td>
<td>343,4</td>
<td>250398</td>
<td>47084</td>
</tr>
</tbody>
</table>

**Table 2. Sum of linier regression component**

**Table 3. Summary of equation and value of R in every mainroad**

<table>
<thead>
<tr>
<th>No</th>
<th>Name of Road</th>
<th>Equation</th>
<th>( R ) Square</th>
<th>Sff</th>
<th>( D_j )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mayjen Sungkono</td>
<td>( y = 32,14 - 0,016.x )</td>
<td>0,367</td>
<td>32,14</td>
<td>2008,75</td>
</tr>
<tr>
<td>2</td>
<td>Ahmad Yani</td>
<td>( y = 37,51 - 0,027.x )</td>
<td>0,892</td>
<td>37,51</td>
<td>1389,26</td>
</tr>
<tr>
<td>3</td>
<td>Darmo</td>
<td>( y = 39,04 - 0,039.x )</td>
<td>0,785</td>
<td>39,04</td>
<td>1001,03</td>
</tr>
<tr>
<td>4</td>
<td>Diponegoro</td>
<td>( y = 37,28 - 0,036.x )</td>
<td>0,729</td>
<td>37,28</td>
<td>1035,56</td>
</tr>
<tr>
<td>5</td>
<td>Basuki Rachmad</td>
<td>( y = 36,13 - 0,031.x )</td>
<td>0,772</td>
<td>36,13</td>
<td>1165,48</td>
</tr>
<tr>
<td>6</td>
<td>Urip Sumohardjo</td>
<td>( y = 32,51 - 0,018x )</td>
<td>0,249</td>
<td>32,51</td>
<td>1806,11</td>
</tr>
<tr>
<td>7</td>
<td>Ir.H.Soekarno</td>
<td>( y = 39,13 - 0,037.x )</td>
<td>0,699</td>
<td>39,13</td>
<td>1057,57</td>
</tr>
<tr>
<td>8</td>
<td>Kenjeran</td>
<td>( y = 43,31 - 0,059.x )</td>
<td>0,833</td>
<td>43,31</td>
<td>734,07</td>
</tr>
<tr>
<td>9</td>
<td>Manyar Kertoardjo</td>
<td>( y = 36,59 - 0,037.x )</td>
<td>0,327</td>
<td>36,59</td>
<td>988,92</td>
</tr>
<tr>
<td>10</td>
<td>Tunjungan</td>
<td>( y = 34,37 - 0,041.x )</td>
<td>0,434</td>
<td>34,37</td>
<td>838,29</td>
</tr>
</tbody>
</table>

**Figure 1. Graphic of D vs S at Mayjen Sungkono road**
Figure 2. Graphic of D vs S at Ahmad Yani road

Figure 3. Graphic of D vs S at Raya Darmo road

Figure 4. Graphic of D vs S at Diponegoro road

Figure 5. Graphic of D vs S at Basuki Rachmad road

Figure 6. Graphic of D vs S at Urip Sumohardjo road

Figure 7. Graphic of D vs S at Ir. H. Soekarno road
Furthermore to see the relationship of mathematical models Greenshield on each road artery to describe the relationship chart simultaneously mathematical model that can be seen as in Figure 11. For the relationship S and D, Figure 12. For the relationship V and D and Figure 13. For V relationships and S.
CONCLUSION

From the analysis conducted on the basis of the density of mathematical models Greenshield, it can be concluded that the arterial roads that have the highest traffic volume is Ahmad Yani roads with a total of 129,911 pcu/hr and the lowest with a value of 47,084 is a Tunjungan street in a pcu/hr.

For the free flow speed or SFF obtained from the calculation results showed that roads Kenjeran has the highest speed with a value of 43.3 km/hr and road MayJen.Sungkono which has the lowest rate with the value of 32.1 km/hr.

The current density saturated from current path can be concluded that the roads Urip Sumohardjo have high levels of saturated highest current density of 1807 pcu/km and Kenjeran roads have the lowest density of 735 pcu/km.

ACKNOWLEDGMENT

The author would like to thank Kemenristek Dikti for his help in the research program faculty for the provision of research grants from DP2M Dikti with skim competitive grants in 2016, also to LPPM UPN Veteran Jawa Timur, which already provides ease of administration process research reports and do not forget to study program of civil engineering which already provides laboratory facilities, traffic engineering and GIS so that this research can work well.
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Alamsyah A.A., 2005, Rekayasa Lalu Lintas, Penerbit UMM, Malang
Leksmono Suryo Putranto, (2008), "Rekayasa Lalu Lintas", CV. Indeks, Jakarta
ABSTRACT

We analyzed the thickness and profile of the flow of liquid films on the hydrophilic surface of the disk. This disc rotates vertically, whose condition partially immersed in the water. We measured the wettability of the liquid film on the surface of the disk by varying the speed of rotation, the depth of the water and surface roughness of the disc. In the experiment, we found that a hydrophilic surface on a flat disc produces no slip conditions on the flow of liquid film. And the average thickness of the liquid film, a linear relationship with the disk rotation speed. But on a topographical hydrophilic surface, the average of thickness of liquid film did not follow a linear equation, but the fourth order polynomial equation. And a profile thickness of liquid film on the topographical hydrophilic of surface was also different than the flat disc.

Keywords : hydrophilic surface, topographical surface, liquid film, rotating disc, fluid no slip

INTRODUCTION

The geometric constraint of a solid surface, as well as the interactions between water and the solid, lead to structural changes of water compared to its bulk properties. It implications of flows in porous media, boundary lubrication, and in the vast majority of mass transfer process. It is accepted that surface roughness [3,6,13] surface wettability [2,5,7,8,9] influence the interaction between liquid and solid at the interface. Surface can be divided into two classes according to their affinity to water: hydrophilic, water attracting, and hydrophobic, water repellant [16,21].

In a rotating disk contactor, the disc are partially immersed in the water. As a consequence of the rotation, a liquid film is brought upwards over the surface of the discs, thus providing a contact of the film with the gas phase above the water. After moving downwards the liquid film will be taken up again by the bulk of water in the trough. The recirculated water film will be homogeneously mixed with the bulk of the liquid.

The thickness of the liquid film on the discs plays an important role, particularly at low rotational velocities in mass transfer studies. The formation of films on rotating discs on the one hand and flat plates withdrawn from a liquid on the other hand [4,14,18-19]. The withdrawal of flat plates from liquids has been examined thoroughly, both experimentally and theoretically [14]. The flat plate withdrawal theory [12,14] states that withdrawal of a smooth infinitely long flat plate from a liquid with a velocity results in an adhering film of thickness $\delta$ which can be calculated as a function of the effects of gravity, withdrawal velocity and physical properties of the fluid. This may be expressed as follows:

$$\delta = K \left( \frac{\rho w R^3}{\mu g} \right)^{1/2}$$

(1)

Where, $\delta$ is liquid film thickness ($\mu m$), $\mu$ is dynamic viscosity of water ($kg.m^{-1}.s^{-1}$), $\rho$ is density of water ($kg.m^{-3}$), $\omega$ is angular velocity (rpm), $R$ is radius of disk (m). The connection between $\delta$ with $\omega^{0.5}$ is linear. In mass transfer of oxygen, the values in this case is directly dependent on the actual film thickness $\delta$ [4,15,17,20]. Zeevankink [14] made an independent study and obtained a theoretical derivation for the film thickness $\delta$ on rotating discs based on the flat plate withdrawal theory. In his experiments to determine the thickness $\delta$, the method of volume was used [14]. How it works: a number of water entrained on the disk when exposed to the air due to rotation was measured with a sponge attached to the disk (along the surfaces which is not submerged, this is called the thickness area of ultimate film), see Figure 1. Thus, the formula becomes:

$$\delta = \frac{M}{\rho \pi (R^2 - H^2)}$$

(2)

Where $M$ is weight increase (gram).

He related $\delta$ to be a function of the rotational velocity as well as depth of immersion in addition to the forces of gravity and viscosity. He explained that the disk rotation speed was the speed of the vertical peripheral disk. It was a function of rotation speed and the depth of the disk. It also fitted the experimental data, with a correlation coefficient of 0.99 [4]. Therefore, equation (1) has been used for the theoretical calculation of average $\delta$ values over the exposed disc surface in the model.
The determination of the thickness of the liquid film on the vertically rotating flat disk, continued by Sanjay [11], using Laser Distance Sensor to measure the thickness of the liquid film. It was proved that larger disc diameter need more peripheral speed [1,11]. The studies above, not to consider the factor of surface roughness and its influence on the thickness of the liquid film attached to the disk when it is out of the water surface. This research studied the thickness profile of the liquid film on the rough disk surface was varied.

2. Experimental setup

For the experiment use, has been made a laboratory scale rotating disc apparatus (see Table 1). The variation was used on the material type as the disk ingredients and surface topography. The material type as the disk ingredients was used from novotex and acrylic. Meanwhile, on the disc’s surface topography were done three topographical variations. The water tank was formed as semi-cylinder shaped and made of acrylic. The depth of immersion of the discs was varied by varying the water level in the trough. For practical reasons only the outer discs were used for the measurements. The water temperature was kept at 26±0.5°C.

There were some methods to measure the liquid film thickness patched to the vertically rotating disk. But in this study, because the liquid film’s thickness was below 100 μm, and temperature used was 26°C, liquid film that was patched to the disk when it was coming out of water, the thickness was below 100 μm, so it was hard to be detected.

In this study, the amount of water entrained by the discs was measured by holding sponges against one of the discs (in Fig.1, along the line CD which is in the region of ultimate film thickness). After one or two rotations the increase of weight increase M per rotation the mean film thickness was calculated assuming that the water was equally spread over the disc and that the film velocity equals the velocity of the disc, using formula 2 and the formula of the submerged disc area, using disk’s total area.

| Table 1. Reactor design and operating parameters for laboratory scale |
|-----------------|-------------------|-----------------|
| No. | Information | A_f |
| 1. | Number of discs | 1 |
| 2. | Disk Material | Acrylic |
| | | Novotex O |
| | | Novotex I |
| 3. | Diameter of discs (cm) | 23 |
| 4. | Thickness of discs (cm) | 1.0 |
| 5. | Distance between outer disc and trough (cm) | 2.0 |
| 6. | Rotational speed (rpm) | 1; 3; 5; 7.5; 10; 15; 20 |
| 7. | Depth of immersion under from centre of disc (m) | 0.025; 0.063; 0.07 |

On the Figure 2, explained the material variation and the surface’s disk topography

**Figure 2.** Disc as Contactor (a). acrylic; (b).novotex O Represented Hydrofobic Surface and (c). novotex I, represented Hydrophilic Surface

Below on the Figure 3., the reactor that used to measure the liquid film thickness using one disc Rotating Vertically Disc Contactor.
Tools and Materials

1. The main used material was: Tap Water \((T = 26^\circ C; \rho = 0.99681 \text{ g/cm}^3; \nu = 0.8774 \times 10^{-6} \text{ m}^2\text{s}^{-1})\)

2. Main tools that was used in this study such as:
   - The reactor that was designed for one physical model disc was designed easily to measure the rotation speed, depth and disk material switch. The Reactor schema was explained on the Figure 3.1.
   - Disk with the surface’s shape variation and disk material variation, with each form’s width and depth variation (Table 1. The width of each disk variations)
   - Sponges, was used to adsorb the liquid film on the disk.

RESULTS AND DISCUSSION

The Influences of Rotational Speed’s Components on The Flat Surfaced Disk toward the Liquid Film Thickness

The relation of disk material towards liquid film thickness will be discussed further in this subchapter, with looking at liquid film thickness’s profile on every material by varying the depth and rotation speed’s root of the disk.

From the Figure 4 below, gained that the tendency of liquid film's thickness, in acrylic and novotex 0 material, based on the relationship between \(\delta_m\) and rotation speed’s root of the disk, was non-liner. If it was plotted with the 4th order of differential equation (Avanasiev, et al., 2008) then the value of determination coefficient \(R^2\) more than 99%.

![Figure 4](image)
Meanwhile on the novotex I, the relationships between $\delta_r$ with root's rotation speed of the disk was linear. This condition was applied for the variation of the water depth under the disk's axis and has the determination $R^2$ value above 99%.

From the Figure above, in terms of rotation speed, liquid film's thickness profile at the rotational speed 1-7.5 rpm on the acrylic and novotex O, the liquid film thickness was thin and unstable. Even at 1 rpm, it just teardrops formed that is patched irregularly on the disk surface. At 3 rpm, the liquid film was began to be dragged even at a particular rotation position was getting thick, thin and disappeared, it was hard to measure the liquid film's thickness. So in this study, chosen the disk's rotation position ($\theta$) which has the highest average of the liquid film's thickness, which was in $\omega = 1, 3$ dan 5 rpm, acrylic and novotex O materials, $\theta = 120^\circ$; $\omega = 7.5$ – 20 rpm, acrylic and novotex O materials, $\theta = 220^\circ$ dan $\omega = 1$ – 20 rpm, with novotex I material, $\theta = 220^\circ$.

At the low speed, 1-7.5 rpm ($N_{Re}$ 1004.8; 3014.5; 5024.3; 7536.5 each), where the value of $N_{Re}$ was less than 10,000 as the transitional flow. The liquid film's thickness in that tradition's flow was dominated by viscosity force, so the liquid film's thickness was low (Sanjay, 2007). This matter if we took a review from the Zeevalkink et al., 1978, who used the polystyrene material, the chosen of 6 rpm rotation's speed. Because the low rotation's speed causing the fluctuation of the liquid film's thickness value and hard to be detected. It was different with the liquid film thickness in novotex I, which was relatively not being fluctuated towards the root of rotation's speed. So at the low rotation's speed (1-7.5 rpm) until the average speed (10-20 rpm) profile $\delta_r$ towards $\omega^{0.5}$ was linear. This condition was called no-slip by Avanasief et al., 2008), that was the condition where the water patched well to the surface of particular solid. The reverse was slip condition, where the water patched to the solid imperfectly, just like in material novotex O and acrylic.

Reviewed from the variations of the water depth with the variation at 19.6%, 22.6% depth and 39%, by the result of the study it was gained that the average liquid film thickness at 39% depth compared with the other depths, dominantly higher. This term was applied for the variation of the material types too; the experiment's result showed at 39% depth the liquid film's thickness was the highest average. This matter was also happened on the Zeevalkink et al., 1978 that also varying the disk depth, at the 29 %-38 % depth variations, the liquid film thickness value has the higher value on the flat surfaced disk.

If it was looked from the tendencies of relationship $\delta_r$ towards $\omega^{0.5}$ on the acrylic and novotex O, was non linear. This condition was explained by Avanasief et al., 2008, who studied liquid film's distribution on the flat-surfaced disk, at the low rotation's speed (0.277, 1 dan 2 rpm).Gained the liquid film thickness profile was non linear, the 4th order differential equation. That equation was done by numeric method, finite element by varying disk depth and rotation's speed. So in this study, was using 4th order differential equation. The gained result, in acrylic and novotex O the determination coefficient value ($R^2$) in average was more than 99%. Meanwhile at novotex I, was linear because it has the determination value ($R^2$) more than 99%. The same correlation that was used by Bintanja et al., 1970 and Zeevalkink et al., 1978.

The Relation of Disk Material towards Liquid Film Thickness

As for the type of material's surface which was correlated with the contact to the water, were divided to hydrophilic and hydrophobic. The difference from those materials was if the surface of the material was hydrophilic, then the water will be dragged easier and patched well when the disk spinning upside, so the speed's assumption of the disk's rotation was same with the liquid film rotational speed (Zeevalkink et al., 1978). Below on the Figure 5 the visualization of the water drops in each disk's surfaces.
The visualization of the water drops on each disk’s surfaces, (a) acrylic; (b) novotex O; (c) novotex I.

The characteristics of the disk’s surface was strongly related with the surface’s ability to drag out some amount of water while it was dragged out of water, and dragged in to the water. The profiles of the three materials were, on the acrylic, water was easily slipped out when it was dragged by the disk upside. At 20 rpm speed, water cannot fulfill all of the exposed disk area, the value of r (water’s radius that was dragged by the disk) was half from the exposed area. Meanwhile at the novotex O, it was much better in dragging the water rather than the acrylic did, and the value of r was bigger than on the acrylic, but at the low rotation’s speed, the liquid film was hard to patch onto the disk. The novotex I, the water was not dragged. So if the rotations speed increased, the water thickness was seen to be increased, so the theory which proposed by Zeevalkink et al., 1978 can be clearly seen. It was only there was a factor of water diffusion on the novotex I surface’s area, so when the water was cleaned, still left on the novotex I, it needed around less than one minute to dry.

From Figure 5 the visualization of the water on the disk’s surface, if it was looked by the contact angle factor. The measurement result of the visualization above, roughly gained the average contact angle for each disk materials, Acrylic, $\alpha = 48^\circ$; novotex O, $\alpha = 57^\circ$; novotex I, $\alpha = 36^\circ$. On the novotex I material type, the lowest water drops, the average was $36^\circ$ and the study’s result indicates that the liquid film thickness value was showing the highest if compare than two other materials. The Figure above was captured on the room temperature at 28°C - 31°C, the clean water characteristic that used was $\rho = 0.99681$ gr/cm$^3$; $\nu = 0.8774 \times 10^{-6}$ m$^2$/s. This condition will be different if the temperature factor, density and the viscosity changed. It was based on the Bico et al., 2001 that said the hydrophilic condition will be at $\alpha \leq 80^\circ$, if the temperature was at 19-20°C.

**Velocity component and roughness surface of disc in statistical test toward Liquid film’s thickness on the flat-surfaced disc.**

In this study, the unbalanced factorial design statistical test for 3 factors was chosen. The factorial design was chosen in order to analyze the interaction among the factors to influence the response, and detect the influence of inter-level factor at the same time. from the study, there were 3 factors which considered to influence the liquid film’s thickness such as : disk material’s type, rotation speed and disk’s depth.

Factorial test’s result for the flat-surfaced disk, for F and p, the ANOVA output’s result, gained that the surface’s roughness and rotation’s speed as the main factor took a big effect to the liquid film’s thickness. Meanwhile the disk’s depth variable on the flat disc had a low influence to the liquid film thickness. Explained in the Figure 6.
ors gratefully acknowledge to the

Meanwhile the disk’s depth was less influencing. With the optimal value on the single disc, at 39% depth, rotation’s speed was at 7.5-10 rpm and the material type that used was hydrophilic. Liquid film thickness profile on the single flat disc RBC from the statistical test’s result was strongly influenced by rotation’s speed and the material type. Meanwhile the disk’s depth was less influencing. With the optimal value on the single disc, at 39% depth, rotation’s speed at 7.5-10 rpm and the material type that used was hydrophilic.

ACKNOWLEDGEMENTS

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INTRODUCTION

An area cannot stand alone completely meet the needs of its own regions so that the area in need of other areas as support, a means of connecting means transportation or transportation. In the absence of transport is a means of supporting, can not be expected to achieve maximum results in the effort to realize the development goals. Transport plays an important role in the construction and development of an area related to the mobilization of the movement of the flow of people and goods/services (Khisty, 2006). This led to the development of transport especially in the city of Surabaya growing ly due to the increased public need for mass transportation.

One example is otobus. Otobus is a company providing passenger transport services by public transport on the road route between cities within the province (AKDP) and inter-city inter-province (AKAP). The growing state companies otobus in the city of Surabaya lead to competition between these companies more clearly visible in order to seize the consumer. In this competition also brings positive and negative impacts. One positive impact is PO.Sumber Group has opened an “PATAS” to track JOGJA - SEMARANG - SOLO - SURABAYA via Karangjati at the beginning of 2015. Initially have a fleet of eight units with the name SUGENG RAHAYU by GOLDEN STAR. Under the protection of the company SUMBER GROUP and under the management of Golden Star. Unit 8 is 4 for the bus serving the route Yogyakarta-Solo-Surabaya and 4 units to the route Semarang-Solo-Surabaya.

One of the factors that can determine customer satisfaction is the customer’s perception about the quality of services. Assessment of customer satisfaction is a requirement for management. Ratings satisfaction is an evaluation for management to improve service and win the competition. Already a fundamental need, both for individuals and companies in improving productivity and improved quality of service to consumers, especially in the transportation business.

Based on the description above, the writer interested in studying the problems as follows:

1. How the characteristics user of Sugeng Rahayu “Patas” bus?
2. What percent customer satisfaction rate faster Sugeng Rahayu “Patas” bus?

The purpose of this study was to measure customer satisfaction fast Sugeng Rahayu “Patas” bus as an attempt to increase quality of its services. Overall subscriber satisfaction can be measured using the Customer Satisfaction Index (CSI) (Arita, 2005). To create value for customer satisfaction in the effort to control the quality of services, there are five dimensions of quality is the focus on quality of service, namely tangibles.
Quality of services / Services

According to J.Supranto (1997) Quality is a word that for service providers is something that must be done well. Application quality as the nature of the product appearance or performance is a major part of corporate strategy in order to achieve sustainable excellence, both as a market leader or as a strategy to continue growing. In the context of quality products (goods and services) and satisfaction, has reached a consensus that the expectations customers have a large role as a standard of comparison in the evaluation of quality and satisfaction. According to Olsen and Dover, as quoted by F.Tjiptono (1998), the expectations of customers is the customer confidence before trying or buying a product, which is used as a standard or benchmark in assessing the performance of the product. One way services company to continue to excel and compete is to provide services with higher quality than its competitors consistently.

Customer expectations shaped through past experiences, talks of mouth and promotion done by a service company then comparability.

According to Kotler cited Total Quality Management of the book there are several methods that can be used in measuring customer satisfaction, among others (Tjiptono, 2005).

1. System of complaints and suggestions
   Customer-centered organization that is provides ample opportunity to its customers to submit suggestions and complaints. This information can provide good ideas and allow it to be responsive and react to address the problems that arise.

2. Ghost shopping
   Customer-centered organization that is provides ample opportunity to its customers to submit suggestions and complaints. This information can provide good ideas and allow it to be responsive and react to address the problems that arise.

3. Lost customer analysis
   Companies should contact customers who have stopped buying or who have moved supplier in order to understand why it happened. Not only exit interviews are necessary, but monitoring is also important customer loss rate, increased customer los rate shows the failure of the company in satisfying customers.

4. Customer satisfaction survey
   Generally, research on customer satisfaction survey conducted by the research, either by post, telephone or direct interviews. The Company will obtain responses and feedback directly from customers and also give a sign (signal) is positive that the company pay attention to its customers.

Customer Satisfaction Index

Measurement of the customer satisfaction index (Customer Satisfaction Index) is required because the results of these measurements can be used as a reference for determining targets in the coming years. Without a customer satisfaction index of top management may not be able to determine the target in increasing customer satisfaction. Besides the index is also necessary because customer satisfaction measurement process is continue.

How to calculate the index of customer satisfaction are:

1. Calculate Weighting Factors (WF)
   That is the function of media importance score or score median level of importance of each attribute in the form of 5% of median importance score or score median interest rate for all attributes tested.

2. Calculate Weighted Score (WS)
   The function of the median satisfaction score or score median level of satisfaction each attribute – each multiplied by Weighing Factors (WF) each attribute.

3. Calculate Weighted Median Total (WMT)
   The total value of Weighted Score (WS) overall.

4. Customer Satisfaction Index
   Is calculation of Weighted Median Total (WMT) divided by the maximum scale or scale higest multiplied by 100%.

Respondents overall satisfaction level can be seen on the criteria of customer satisfaction or customer, with the following criteria:

- a. 0,81 – 1,00 Very satisfied
- b. 0,66 – 0,80 Satisfied
- c. 0,51 – 0,65 Quite satisfied
- d. 0,35 – 0,50 Less satisfied
- e. < 0,50 Not satisfied

METHODOLOGY

The data used in this study is a combined qualitative and quantitative data obtained through interviews and surveys using questionnaires. While the instrument used in this questionnaire using 14 items. Test the validity of a step in the tests performed on the content (content) of an instrument, with the aim of measure precision instrument used in a study (Sugiyono, 2006). While
Reliability is an index that shows indicate the extent to which a measurement is reliable or unreliable (Singarimbun, 1987). After the pilot study and obtained a valid instrument and new reliable study done playing. While the determination of the number of respondents involved in this study played by Steer Davies Gleave revealed that in order to get more good result even could use a sample size between 75 to 100 samples. Thus in this research study was conducted by taking a sample of 100 respondents.

**RESEARCH AND DISCUSSION**

The demographic characteristics of the customer based on the results of the study were divided into four groups, namely sex, age, occupation and income level per month. Based on this research, it is known that most customers Sugeng Rahayu “Patas” bus female visitors as many as 54 people (54%), while the male visitors as many as 46 people (46%). Data customer distribution by sex can be seen in the following figure.

![Figure 1. Percentage respondents by sex.](image)

Based on this research, it is known that most of the customers Sugeng Rahayu “Patas” bus is a passenger with age 26-35 years (28%) while visitors with age> 55 years, only 8%. Data customer distribution by age can be seen in the following figure.

![Figure 2. Percentage respondents by age.](image)

Based on the research results, the majority of customers Sugeng Rahayu “Patas” bus is to have an average monthly income with the largest percentage of Rp.2.500.000 - Rp. 5.000.000 with a percentage amount by 34%. Data distribution customers by income level can be seen in the following figure.

![Figure 4. Percentage of Respondents by income level.](image)

**Validity Test**

Validity test was intended to determine the extent of gauges (instrument) measure what you want measured. Validity test is used to calculate the value of the correlation (r) between the data on each question with a total score. Validity test in this study with the help of Microsoft Excel 2007. The correlation is calculated declared invalid if $r > r_{Table}$, $r_{value table}$ is 0.1946. Based on the results of the processing of each attribute to level performance and the importance obtained that questionnaire is valid.

**Reliability Test**

Reliability is a value that indicates the consistency of a measuring instrument in measuring the same symptoms. Reliability test in
this study using Cronbach’s Alpha technique with the help of Microsoft Excel 2007. The results of tests carried out showed that the variables are highly reliable. Cronbach’s Alpha based techniques generated value for the interest rate is 0.929 and for the performance level of 0.793. The value is above the Cronbach’s Alpha value that is equal to 0.1946; this is meaning it can be concluded that the correlation is very reliable.

### Customer Satisfaction Index

Measurement of Customer satisfaction (CSI) was conducted to determine customer satisfaction and provide a guideline in determining the goals, in the future, the absence of CSI, it’s unlikely for a manager can specify the destination in improving consumer satisfaction.

**Table 1. Results of calculation of Customer Satisfaction Index (CSI)**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Statement</th>
<th>The median score level performance</th>
<th>Importance Weighting Factor (WF)</th>
<th>The median score level performance</th>
<th>Weighted Score (WS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The precision of the bus trip schedule</td>
<td>4.59</td>
<td>0.072</td>
<td>3.99</td>
<td>0.29</td>
</tr>
<tr>
<td>2</td>
<td>Time bus operation in accordance with the needs of passengers</td>
<td>4.42</td>
<td>0.069</td>
<td>3.79</td>
<td>0.26</td>
</tr>
<tr>
<td>3</td>
<td>Bus patas Sugeng Rahayu can reliable</td>
<td>4.53</td>
<td>0.071</td>
<td>4.08</td>
<td>0.29</td>
</tr>
<tr>
<td>4</td>
<td>Speed and readiness of personnel to provide services for customers to completion</td>
<td>4.50</td>
<td>0.071</td>
<td>3.99</td>
<td>0.28</td>
</tr>
<tr>
<td>5</td>
<td>The speed and accuracy of officers in providing information needed by the customer</td>
<td>4.47</td>
<td>0.070</td>
<td>3.99</td>
<td>0.28</td>
</tr>
<tr>
<td>6</td>
<td>Security of vandalism acts during the trip</td>
<td>4.64</td>
<td>0.073</td>
<td>4.13</td>
<td>0.30</td>
</tr>
<tr>
<td>7</td>
<td>Comfort when going up and down the bus</td>
<td>4.60</td>
<td>0.072</td>
<td>4.06</td>
<td>0.29</td>
</tr>
<tr>
<td>8</td>
<td>The availability of insurance or guarantee of salvation</td>
<td>4.26</td>
<td>0.067</td>
<td>3.49</td>
<td>0.23</td>
</tr>
<tr>
<td>9</td>
<td>Ticket prices offered</td>
<td>4.71</td>
<td>0.074</td>
<td>4.40</td>
<td>0.33</td>
</tr>
<tr>
<td>10</td>
<td>Courtesy clerk in serving passengers</td>
<td>4.48</td>
<td>0.070</td>
<td>3.89</td>
<td>0.27</td>
</tr>
<tr>
<td>11</td>
<td>Cleanliness inside the bus</td>
<td>4.75</td>
<td>0.075</td>
<td>4.16</td>
<td>0.31</td>
</tr>
<tr>
<td>12</td>
<td>The cleanliness of the toilets in the bus</td>
<td>4.53</td>
<td>0.071</td>
<td>2.88</td>
<td>0.20</td>
</tr>
<tr>
<td>13</td>
<td>A transit point for a draw</td>
<td>4.59</td>
<td>0.072</td>
<td>4.02</td>
<td>0.29</td>
</tr>
<tr>
<td>14</td>
<td>Bus fleet interesting and good condition</td>
<td>4.59</td>
<td>0.072</td>
<td>4.34</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>63.66</strong></td>
<td><strong>1.00</strong></td>
<td><strong>55.21</strong></td>
<td><strong>3.95</strong></td>
</tr>
<tr>
<td><strong>Weighted Average</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>3.94</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table above shows CSI score of **0.790**, where the value of which the value is in the interval 0.66 to 0.80, which means the value of customers *"satisfied"* with the services provided by bus patas Sugeng Rahayu. These results indicate there is no gap / gap between customer expectations with the quality of service received by customers. This indicates that the service rendered by the Sugeng Rahayu “Patas” bus in accordance with what is expected by the user. For that feedback can be given is that the Sugeng Rahayu “Patas” bus is to maintain the achievements if necessary enhanced to improve performance is still lacking. Evaluation and corrective action peril improved is the cleanliness inside the toilet in order to be more, because there much bus fleet in toilets clean state.

**CONCLUSION**

Based on the results of data processing and analysis has been done, it can be concluded that satisfaction customer Sugeng Rahayu “Patas” bus overall satisfied. This is evidenced by the value of Customer Satisfaction Index (CSI) obtained is between 66% -80%, is by **79%**. Fast bus so Sugeng Rahayu expected but could maintain these achievements. But although the analysis shows a good value but there needs to be improvement of
service quality, especially the cleanliness of the toilets in the bus. So with the efforts of Sugeng Rahayu “Patas” bus in improving the quality of its services can increase consumer satisfaction.

For further research, should be necessary to add attributes in order to obtain more detailed information of customer satisfaction. While for the analysis of the discussion can be added by the method of Important Performance Analysis (IPA) in order to obtain the results of what type of services that must be maintained and needs to be improved.

ACKNOWLEDGMENT
The author would like to thank Fitri Rahmad Dhani and Burhan Hidayat as a surveyor in this research.

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ABSTRACT

Following the advice of the government on the absorption of ground water, paving block is the perfect solution for use as a surface hardening soil, a parking lot and other open places that require pavement, but still able to absorb the rain water is approximately 60%. Paving block is a building material made from a mixture of Portland cement or a kind of it, water and aggregates with or without other additives that do not reduce the quality of the paving itself. The fabrication method is done by manual with a load of compaction is influenced by the working force. Village of Medokan Ayu population density is quite high, openings available land is limited so that citizens must be able to manage this village well and correctly to prevent flooding, but the environment was neat and clean and available land sufficient water absorption. The resulting compressive strength at the age of 7, 11 and 21 days is 139.76 kg/cm$^2$, 192.53 kg/cm$^2$ and 196.81 kg/cm$^2$, absorption test results is 13.12 %. From the results of the compressive strength and the absorption obtained then the paving block belongs to the class B allocation for the car park, and high infiltration of rain water is able to absorb large enough so as to maintain the water balance of the soil.

Keywords: paving block, compressive strength, absorption

INTRODUCTION

Following a recommendation government on absorbing ground water, paving block is the perfect solution for use as a surface hardening soil, a parking area and other open places that require pavement, but still able to absorb the rain water is approximately 60% when using paving blocks. The absorption of paving block to more efficiently maintain the water balance of the soil, so that the water storage ground for the better. It ensures the availability of water in the soil and if at any time the ground water that needs to be drilled to be used as an everyday purposes.

Paving block is a material that is easily made and economical value for the constituent materials easily obtained our environment. Likewise, the manufacturing technology could be adapted to the wishes, good shape size and color, pattern and texture of the surface as well as strength. This is what makes the paving blocks are widely used as coating materials decorative ground cover. Village of Medokan Ayu is a village which is quite high population density, land openings available is limited so as citizens should be able to manage this village well and correctly to prevent flooding, but the environment was neat and clean and available land sufficient water absorption.

Paving block (concrete brick) is a composition for building material made from a mixture of portland cement or hydraulic adhesive material or the like, water and aggregates with or without other additives that do not reduce the quality of the paving itself. Paving blocks to the floor can be colored like the original color or given dye in the composition and are used for floors, both inside and outside the building, made for roads, sidewalks and parks etc.

Method for production of paving blocks are commonly used in the community can be classified into two methods:

1. Conventional Methods
   This method is the most widely used by our society, the manufacturing is done by using a tool with a load gablonkan compaction influenced by the power of people working. This method is widely used by the public as a home industry because the tools used are simple, easy in the manufacturing process so that it can be done by anyone. The stronger the force that worked on the more solid, the resulting paving block.

2. Method of Mechanical
   This method is commonly called a press method, this method is used by the factory with a medium or large industrial scale, requires a tool which is relatively expensive. Manufacture of paving blocks mechanically done by using the engine (compression apparatus)

In this devotion using conventional methods for empowering the village community Medokan Ayu District Rungkut.

Quality requirements paving block according to SNI-03-0691-1996 as follows:

Properties Appear

Paving block should have a perfect shape, there are no cracks and defects, corners and ribs not easily be destructed with your fingers.
Shape and size

Various shapes and sizes of concrete bricks for flooring, available in the market depending on the manufacturer. Usually each manufacturer provides written explanations in the leaflet regarding the shape, size and carrying capacity and construction of the installation to the floor. Deviations brick thick concrete floor which allowed for a minimum of ± 30 mm with a tolerance of ± 8%.

Physical Properties

Concrete bricks for the floor should have a quality of compressive strength and moisture absorption as in the table below (SNI 03-0691-1996):

<table>
<thead>
<tr>
<th>Quality</th>
<th>Function</th>
<th>Compressive Strength (Mpa)</th>
<th>Absorption Max (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pavement</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>Parking Lot</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>Pedestrian</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>City Park</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: British Standard Institution, 1986

Based on the British Standard Institution, the quality of which must be met by paving blocks are as follows:

1. To obtain the maximum value of the compressive strength, thickness of paving blocks at least 6 cm square shape
2. For the paving blocks using ropes profile of water on the upper surface, a thick rope of water a maximum of 7 mm from the side and the outside of the paving block
3. Deviation allowable dimensions of paving blocks are as follows:
   a. Length ± 2 mm
   b. Width ± 2 mm
   c. Thick. ± 3 mm
4. For the calculation of the compressive strength of the thickness correction factors are used to value

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Paving Block Without Water Rope</th>
<th>Paving Block by Water Rope</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 - 65</td>
<td>1.00</td>
<td>1.06</td>
</tr>
<tr>
<td>80</td>
<td>1.12</td>
<td>1.18</td>
</tr>
<tr>
<td>100</td>
<td>1.18</td>
<td>1.24</td>
</tr>
</tbody>
</table>

METHODOLOGY

In this study, we tried to find out the composition of cement, sand and abu batu resulting mixture paving block effective and maximum quality. After the trial showed the composition of the mixture has been planned and classified according to quality that has been required in SNI 03-0691-1996. He composition of the mixture that has been planned is as follows 1 PC: sand 1.5: 1 abu batu and water cement ratio 0.5. The process of making the test specimen block paving done manually as follows:

Sand and abu batu mixed thoroughly then add water stir the cement enter the appropriate composition of the mixture, after homogeneous paving press enter into a mold using a wooden beam as he is struck using a rubber mallet. By using a plywood sheet, mold behind the paving block and remove the results of the specimen then aerated.

To give good results, the necessary storage and maintenance of specimen that have been printed with the aim of preventing the loss of water used for the hydration process between cement and water. Treatments performed after molded paving block is to be placed in a temporary storage place for twenty-four hours, once that is done the watering for two days then testing the compressive strength of paving blocks at the age of 7 days, 14 days and 21 days. Compressive strength = P / A: 1:06 (kg/cm²), P is compressive load (kg), A is the area of the field press (cm²) and 1:06 is the correction factor paving block 6 cm thick. The results of compressive strength of each age is an average of 3 specimen.

Testing of water absorption of paving blocks (ASTM C642-97) as follows take on specimen that have been soaked for 24 hours, dry surface is then weighed (A). After the specimen is dried in an oven for 24 hours, then weigh the severity of (B). Weighing difference is the amount of water absorption, can be calculated using the formula: Water absorption = (A-B) / B x 100%. The result of water absorption is an average of 3 specimen.

RESULTS AND DISCUSSION

Steps to make paving blocks with a mixture of 1 cement: sand 1.5: 1 stone dust, water cement ratio 0.5.
Results paving compressive strength for the ages of 7 days, 11 days and 21 days as in the following table:

<table>
<thead>
<tr>
<th>Age (Days)</th>
<th>Area (cm²)</th>
<th>Press (ton)</th>
<th>Compressive Strength (kg/cm²)</th>
<th>Average Compressive Strength 28 hari (kg/cm²)</th>
<th>Average Compressive Strength 28 hari (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
<td>220.5</td>
<td>33</td>
<td>141.19</td>
<td>199.66</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>220.5</td>
<td>33</td>
<td>141.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>220.5</td>
<td>33</td>
<td>141.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>220.5</td>
<td>40</td>
<td>171.14 *</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>220.5</td>
<td>47</td>
<td>201.09</td>
<td>192.53</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>220.5</td>
<td>44</td>
<td>188.25</td>
<td>246.83</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>220.5</td>
<td>44</td>
<td>188.25</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>220.5</td>
<td>45</td>
<td>192.53</td>
<td>196.81</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>220.5</td>
<td>75</td>
<td>320.88 *</td>
<td>205.01</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>220.5</td>
<td>47</td>
<td>201.09</td>
<td></td>
</tr>
</tbody>
</table>

* Value not taken into account in the calculation of the average compressive strength

**Figure 2.** How to make Paving Block

**Figure 3.** Compressive Strength Test Results Paving Block Age 7 Days

**Figure 4.** Compressive Strength Test Results Paving Block Age 11 Days
From figure 6, obtained the expected average compressive strength of paving blocks 28 days was 217.17 kg / cm², thus paving block quality B as in table 1. As for absorption is obtained as in Table 4 and Figure 5 as below.

### Table 4. Absorption Paving Block Test Results at 28 days

<table>
<thead>
<tr>
<th>No</th>
<th>Wet Weight (A) (kg)</th>
<th>Oven Dry Weight (B) (kg)</th>
<th>Absorption (%)</th>
<th>Average Absorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2716</td>
<td>2383</td>
<td>13.97</td>
<td>13.12</td>
</tr>
<tr>
<td>2</td>
<td>2687</td>
<td>2357</td>
<td>14.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2668</td>
<td>2395</td>
<td>11.40</td>
<td></td>
</tr>
</tbody>
</table>

Paving blocks absorption test results at 28 days on average 13.12%, thus paving block capable of absorbing water large enough so as to maintain the condition of groundwater and environmental conditions remain tidy as expected.

### CONCLUSION

As shown in Table 3 and Figure 6, obtained an average compressive strength of the paving blocks 28 days was 217.17 kg / cm², and absorption paving average was 13.12% as shown in figure 7, thus paving block B categorized with quality that is intended for car park. Able to absorb rainwater seepage is large enough that 13.12% so as to maintain the water balance of the soil and environmental conditions were immaculate.

### ACKNOWLEDGMENT

First we would like to thank the LPPM which gives the opportunity to perform community service, so motivated us to apply the knowledge they have found and can be useful to society. Next we would like to thank Mr. Ruddy Kusuma Djaya as chairman of RT 10 RW 2 Village Medokan Ayu, District Rungkut who has received us with open arms and enthusiasm were high that the implementation of community service running smoothly.

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