Physical Characteristics of Laboratory Tested Concrete as a Substitution of Gravel on Normal Concrete

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Abstract - Concrete technology is highly potential in the field of construction for structural and non-structural construction. The amount uses of this concrete material raise the problem of solid waste in the form of concrete remaining test results in the laboratory. This waste is usually just discarded and not economically valuable. In solving the problem, this experiment was made new materials by using recycle material in the form of recycled aggregate which aims to find out the strength characteristics of the used concrete as a gravel substitution material on the normal concrete and obtain the value of the substitution composition of gravel and used concrete that can achieve the strength of concrete according to the standard. Testing of concrete characteristic is one of the requirements before starting the concrete mixture. This test using SNI method (Indonesian National Standard) with variation of comparison (used concrete : gravel) were 15:85\%, 25:75\%, 35:65\%, 50:50\%, 75:25\%. The results of physical tests obtained the mud content value of the mixture gravel and used concrete is 0.03 larger than the standard of SNI 03-4142-1996 that is equal to 1.03\%. so the need watering or soaking before use. The water content test results show an increase in the water content value if the composition of the used concrete increases. While the specific gravity value for variation 15:85\% until 35:65\% fulfilled the requirements of SNI 03-1969-1990. the other variasion s show the specifics gravity value included on the type of light materials.

Keywords: Characteristic; Substitution gravel; Used concrete; Waste

1. Introduction

The main building materials that are widely used in the construction of buildings are concrete, such as buildings, bridges, docks, houses, and others. The development of concrete technology has great potential in the field of construction, both for structural and non-structural construction. The use of concrete materials in buildings is not only done by Indonesia but throughout the country. The amount used of this concrete material raises the problem of solid waste in the form of concrete residual strength test results which is a requirement in building a building and concrete residual collapse of the building that will do the renovation. This concrete waste is usually only discarded and not economically valuable.

In solving the problem, a new concrete test is made using recycled aggregate material. Based on Suharwanto's [1] research results, recycled aggregates contain 25-45\% mortar for coarse aggregates, and 70-100\% for fine aggregates. This affects the water uptake that will occur in the new concrete.

The recycled aggregate has a tensile strength value and its poisson ratio is relatively the same as the natural aggregate concrete. As well as the typical values of reconstituted recycled aggregate concrete elements also have a performance and collapse pattern that is relatively equal to the typical value of natural aggregate concrete elements, only slightly lower ductility values [2]. The recycled aggregate composition affects the shrinkage of the concrete. The more recycled aggregate composition the shrinkage value on the concrete is greater. To overcome this problem, the mixing of homogeneous concrete was done by adding subtle patio materials to the mixture [3].

This research was done to utilizing used concrete as a normal concrete material so that it can reduce the price of concrete. The use of recycled materials is not known in general. However, using recycled aggregates can reduce the price of each volume of concrete, since the ingredients are obtained from waste that is relatively lower than the natural aggregate. The low price of concrete will affect the ability of the community to build residential...
houses to be permanent, so that the rate and expansion of the development can be increased up to the remote villages.

Aggregates are natural mineral granules that serve as fillers in mortar or concrete mixtures. This aggregate occupies approximately 78% of the volume of mortar or concrete. Although only as fillers but aggregates greatly affect the properties of mortar or concrete so that aggregate selection is an important part in the manufacture of mortar or concrete. As with the alternative use of burned concrete fractions as a coarse aggregate, because the condition at this time aggregate began to decrease and the price soared. This kind of thing is experienced by some areas that are difficult to get material for the building, because some areas of material resources are forced to close.

Based on SNI-03-6820-2002 [5] there are requirement for gravel in concrete. The larger the fine modulus values of an aggregate means the greater the aggregate grain (the more rough). The fine modulus of sand grains ranges from 1.50 - 3.80. The fine modulus of gravel grains range from 6.0 - 8.0. The fine-grained modulus of the coarse and fine aggregate mixture is 4.0 - 6.0. For mixed aggregate depending on the maximum grain size. The fine modulus of the ideal aggregate grain is based on its grain size, namely: (1)The maximum grain size of 40 mm ranges from 5.5 to 6.0, (2)Maximum grain size of 20 mm ranges from 5.0 - 5.5, (3)Maximum grain size of 10 mm ranges from 4.0 to 4.5. Also for mud contain in fine aggregate (sand) no more than 3% and 1% in gravel.

In concrete, coarse aggregate and fine aggregate fills most of the volume of concrete that is between 60%-80% so that the nature and quality of the aggregate influence on the nature and quality of concrete [6]. The function of the use of aggregate in the concrete is to produce a great strength of the concrete, with good gradation then we will get a solid concrete, and controlling the workability or properties of the concrete mix workable. With a good aggregate, it will get the concrete easier to work or have a good workability.

The used concrete is an unused concrete material for construction. The used concrete used in this study is an industrial test specimen conducted in several university laboratories in Medan.

### 2. Research Method

This research is a laboratory experiment research. The basic materials in this research are cement, sand, natural gravel, recycled gravel (used concrete), and water. In general, this research is divided into two main phases that will be implemented, that is:

#### 2.1 Preparation

At this stage the research begins by determining the compressive strength to be achieved. Then determine the materials of used concrete to be used as gravel substitution on the normal concrete. The used concrete used is the result of laboratory testing of industrial samples in the form of cylinders 15x30 cm in size (as Fig.1). The used concrete is then destroyed manually with a maximum size of 40 mm.

![Figure 1. Laboratory tested concretes](image)

For the natural aggregate used is taken in the batching plan industry. The aggregate used are gravel stone type which is maximal size ¾ " . And the sand material used is the standard sand commonly used for normal concrete mixture. As well as cement materials used are material that meets national quality standards so that for testing the characteristics of cement are no longer needed.

#### 2.2 Stages of completion

At this stage, the physical properties of used concrete as pebble substitution in concrete refer to SNI standard. Comparison of natural recycled aggregate material mixtures and natural aggregates (used concrete: gravel) used in this study were 15: 85%, 25: 75%, 35:65%, 50:50%, 75: 25%. Further laboratory data obtained will be analyzed referring to Indonesian National Standard for normal concrete by taking the mean (average) from the test result data. These tests include testing of moisture content, mud content, specific gravity, water absorption, and filter analysis.
3. Result And Discussion

Preliminary results were achieved in this study is preliminary data research, the water content, silt content, specific gravity and absorption of the former test material mixed concrete and gravel. As well as sieving for fine aggregate (sand).

3.1 Coarse Aggregate Water Content

Moisture content is the magnitude of the ratio between the weight of water contained in the aggregate on aggregate in the dry state (SNI 03-1971 - 1990). Research results obtained from testing the water content of the coarse aggregate (gravel + concrete used) are as follows:

| Examination      | SNI Requirements |
|------------------|------------------|
| Water Content    |                  |
| a) Fine Aggregate| %                |
| b) Coarse Aggregate| % 0.47          |
| c) Used Concrete | %                |
| 1) 15 : 85       | 1) 0.95          |
| 2) 25 : 75       | 2) 1.05          |
| 3) 35 : 65       | 3) 1.40          |
| 4) 50 : 50       | 4) 1.87          |
| 5) 75 : 25       | 5) 2.57          |

The test results obtained from the data the greater the percentage of broken stone, the greater the water content is generated, but if the percentage of gravel is greater then the moisture content value obtained would be lower.

3.2 Levels of Mud

Testing sludge levels aims to determine the levels of sludge contained by fine and coarse aggregates in the laboratory (SNI 03-4142-1996). Fine aggregate and coarse aggregate are good for building materials is for fine aggregate that has a sludge levels below 5%, and for coarse aggregate that has a sludge levels below 1%. If the sludge content of coarse and fine aggregate in excess of that set by SNI then sand or gravel should be washed before being used as a building material. From the research results obtained testing the levels of silt to coarse aggregate (gravel + concrete used) are as follows:

| Examination      | SNI Requirements |
|------------------|------------------|
| Mud Content      |                  |
| a) Fine Aggregate| % 3.01           |
| b) Coarse Aggregate| % 1.03          |
| c) Used Concrete | %                |
| 1) 15 : 85       | 1) 1.05          |
| 2) 25 : 75       | 2) 1.06          |
| 3) 35 : 65       | 3) 1.11          |
| 4) 50 : 50       | 4) 1.13          |
| 5) 75 : 25       | 5) 1.21          |

It can be seen from table 2 that the greater the ratio of the used concrete to the mud found more and more, it is proven by the amount of dust dust attached to the former concrete at the time of solving the former concrete so that the limit determined by SNI 03-4142-1996 has passed the threshold is 1%. However, the mud content for fine aggregate is still within the specified threshold limit of less than 5%.

3.3 Coarse Aggregate Specific Gravity

Specific gravity test aims to determine the specific weight of coarse aggregate and its ability to absorb water. The amount of density that is checked is to aggregate in a dry state, a saturated surface-dry weight (Saturated Surface Dry), apparent specific gravity (Apparent). Density used is a dry density surface (SSD), if the terms of its density aggregate divided into three kinds. (1) Lightweight Aggregate, aggregate is an aggregate that
has a specific gravity less than 2.0, and is usually used for non-structural concrete; (2) Aggregate normal, aggregate normal is the aggregate that has a specific gravity of 2.5 to 2.7. The result of this specific gravity of concrete is about 2.3 with a compressive strength of 15 MPa to 40 MPa.; (3) Weight aggregate, aggregate is pick a specific gravity of more than 2.8. Concrete produced also has a high density (up to 5.0), which is effective as an X-ray radiation protective.

From the results obtained testing the specific gravity for coarse aggregate (gravel + concrete used) are as follows:

| Examination | Unit   | Result | SNI Requirements |
|-------------|--------|--------|------------------|
| Specific Gravity | gr/cm |        |                  |
| a) Fine Aggregate |      | 2.51   | a) ≥ 2.5         |
| b) Coarse Aggregate |     | 2.52   | b) ≥ 2.5         |
| c) Used Concrete |      | 2.53   | c) ≥ 2.5         |

The data from test results obtained by the average - average specific gravity for coarse aggregate is, the specific gravity value for variation 15: 85% until 35: 65% fulfilled the requirements of SNI 03-1969-1990. the other variasion show the specifics gravity value included on the type of light materials.

3.4 Absorption Coarse Aggregates

Absorption Tests aims to determine the seepage in coarse aggregate (gravel) used in the manufacture of concrete. The amount of water is equally important to produce good concrete. Water helps to flatten cement across the gravel and assist stirring. Research results obtained from testing the water absorption of coarse aggregate (gravel + concrete used) are as follows:

| Examination | Unit   | Result | SNI Requirements |
|-------------|--------|--------|------------------|
| Absorption  | %      |        |                  |
| a) Fine Aggregate |      | 1.52   |                  |
| b) Coarse Aggregate |     | 15.86  |                  |
| c) Used Concrete |      |        |                  |

In Absorption Testing, it can be seen that the greater the ratio of the used concrete, the greater the resulting absorption. This happens water enters into the pores of the former concrete.

3.5 Fine Modulus and Gradation Limits

Testing sieve analysis is to determine the fine aggregate gradation or distribution of soil particle size (grainsize distribution) of a soil sample by using a sieve. According to SNI - 03-2847 - 2002, the fine aggregate was natural sand as a result of the disintegration of the ‘natural’ rock or sand produced by stone crushers industries and has the largest grain size of 5.0 mm. British Standard (BS) provides gradation requirements for sand. Sand roughness divided into four groups according to the gradation, which is fine sand (zone 4), rather smooth (zone 3), a bit rough (zone 2) and coarse (zone 1) as in table below:

| No | Examination | Unit   | Result | SNI Requirements |
|----|-------------|--------|--------|------------------|
| 1  | Fine Modulus |        |        |                  |
| a) | Fine Aggregate | a)    | 2.33   |                  |
| b) | Coarse Aggregate | b)   | 6.67   |                  |
In Testing Sieve analysis can be seen that the greater the comparison on the former concrete then the modulus of fineness obtained getting smaller. According to SNI 03-2461-1991 has a fineness modulus of fine aggregate or fineness modulus (FM), which is in the range between 1.5 s / d 3.8. From the test data obtained fine aggregate are in zone 3 and has a fineness modulus of 2.33. These results are in accordance with SNI 03-2461-1991 which states that the fineness modulus of fine aggregate is in the range of 1.5 s / d 3.8.

4. Conclusions
From the results of physical examination, it can be concluded that are: For the comparison of used concrete starting from the ratio of 50:50 to 75:25, including one type of lightweight material aggregate because based on SNI 03 - 1969-1990 value of specific gravity > 2,5 gr / cm used for non structural concrete, and if the specific gravity of 2.6 gr / cm to 2.7 g / cm belongs to the normal aggregate used for concrete with a strength of 15 to 40 Mpa. The characteristics of the material in the test require special treatment to be used as a mixture of concrete, such as the need for watering or soaking before use.

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