The laboratory analysis for water absorption of sandy soil from three different quarry

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Abstract. The research objective was to determine the water absorption and gradation of three types of quarry originating from Pandau, Garuda Sakti and Teratak Buluh. This research is basic research to provide property data of sand soil commonly used in Pekanbaru as a construction material. This study uses experiments in the laboratory by testing the Specific Gravity (SNI-03-1964-1990), testing the Moisture Content (SNI 03-1965-1990), and Testing the Filter analysis (SNI-03-1968-1990). Based on the test results obtained that the sand soil from Pandau quarry has a high water absorption value compared to sand soil from the quarry Garuda Sakti and Teratak Buluh. The soil condition needs to be further handled by making repairs or strengthening if it will be used construction material.

1. Introduction

The area of Pekanbaru City is 632.26 Km, consisting of 12 Subdistricts and 58 villages [1], the increase in the area of Pekanbaru is followed by an increase in demand in all fields requiring sandy soil as a construction material. According to BPS Riau Province [2], utilization of river sand in Riau Province is currently more widely used for building materials. In addition to land taken from rivers, land acquisition is also carried out at quarry C mines whether managed by companies or private companies using sand not only as a building material but can be used as pavement aggregate land [3], [4], stockpile [5], sand printing, cement raw materials and the glass industry [6]. The use of sand soil as a construction material needs to be treated to get maximum results [7].

The land has a very important role as a media foundation to spread the burden of the building into it [8]. Apart from being a recipient of the final load channel, the land is also used as construction material from the building itself, such as dykes and highways. The soil conditions in each place are very different because the soil is naturally a complex and highly variable material. If a land contained in the field is very loose or very soft so it is not suitable for development, then the land should be stabilized [9].

The Land consists of three components, namely: air, water, and solid material (granules). The air is considered to have no technical effect, while water greatly influences the technical properties of the soil. The space between the grain partially or completely can be filled with water or air. If the cavity is filled with water, the soil is partially saturated, dry soil is soil that contains no water at all or has zero water content. Relationships between water content, pore number, porosity, volume weight, specific gravity [10,11] and others are needed in planners [12-14].
The size of the soil grain varies greatly to describe the soil based on the particle size of its composition, some organizations have developed limits on the size of the soil type. Coarse-grained soils can be defined based on grain size, according to MIT Nomenclature of granules larger than 2 mm in diameter, classified as gravel. If the grains can be seen by the eye, but the size is less than 2 mm, it is called sand [15]. Sandy soil is also called coarse sand if the diameter is between 0.6-0.2 mm, and fine sand when the diameter is between 0.2-0.6 mm.

Investigation of the technical characteristics of land [16] is an absolute step that must be carried out in a civil building planning project, especially on large scale projects. To obtain safe and economical design results, it is necessary to investigate the data [17] that is thorough and covers all aspects [18]. This study aims to determine the potential of sand in Pekanbaru which can be used as a construction material.

2. Methods
In this study began by determining the location of sampling based on data from areas that are used as quarry taking sand soil, namely Garuda Sakti, Pandau and Teratak Buluh. Location survey includes determining the observation point, taking pictures. Sampling was carried out by the needs for laboratory testing, sampling was carried out in 3 research areas using a sand shovel and inserted into a plastic sack. Testing sand samples using a filter analysis test that refers to Specific Gravity (SNI-03-1964-1990), testing the Water Content (SNI 03-1965-1990), and testing the Filter analysis (SNI-03-1968-1990). Based on the data obtained then analyzed the comparison of the value of specific gravity, water content and gradation of sand aggregate at the 3 quarry locations so that conclusions can be obtained.

3. Results and discussion
Based on the results of sample testing in the laboratory on the value of specific gravity, water content and gradation of sand aggregate at the 3 quarry locations, the results obtained include:

3.1. Specific gravity testing
The specific gravity testing of the three Quarries refers to the Specific Gravity test (SNI-03-1964-1990), the test results can be seen in Figure 1.

![Figure 1](image.png)

**Figure 1.** Graph of specific gravity.

Based on the test results obtained an average specific gravity for the three quarry namely the specific gravity of Garuda Sakti 1 sample is 2,352, Garuda Sakti 2 is 1,791, Garuda Sakti 3 is 2,433, Pandau 1 is 2,352, Pandau 2 is 2,625, Pandau 3 is 1,895, Teratak Reed 1 is as big as 2,433, Pandau 1 is 2,352, Pandau 2 is 2,625, Pandau 3 is 1,895, Teratak Reed 1 is as big as 1 2,352, Teratak Buluh 2 of 2,774 and Teratak Buluh 1 of 2,015.
3.2. Water absorption testing

Testing of Water Content in the three Quarries refers to the testing of Water Content (SNI 03-1965-1990), the test results can be seen in Figure 2.

Based on the test results obtained in the Water Content for the three Quarry namely the specific gravity of the Garuda Sakti 1 sample is 5.13, Garuda Sakti 2 is 9.88, Garuda Sakti 3 is 10.35, Pandau 1 is 21.61, Pandau 2 is 50.17, Pandau 3 by 35.74, Teratak Buluh 1 by 4.63, Teratak Buluh 2 by 7.89 and Teratak Buluh 1 by 3.25. The test results show that the Quarry Pandau sample has a high water content so it is not good to be used as a construction material, it is necessary to improve the soil to get optimal results.

3.3. Gradation analysis testing

Based on the sieve analysis test, the composition of gradations obtained in the three Quarries refers to the sieve analysis test (SNI-03-1968-1990). The test results can be seen in Table 1.

| Filter Number | Gradation of each faction (Passing the sieve presentation) | Average |
|---------------|-------------------------------------------------------------|--------|
| ASTM          | sample                                                     |        |
| mm            | Garuda Sakti 1     | Garuda Sakti 2     | Garuda Sakti 3     | Pandau 1     | Pandau 2     | Pandau 3     | Teratak Buluh 1 | Teratak Buluh 2 | Teratak Buluh 3 | 100% |
| # 3/8         | 9.52             | 99.75             | 99.67             | 100          | 100          | 100           | 99.85         | 99.74         | 100             | 99.89 |
| No. 4         | 4.75             | 99.12             | 97.68             | 99.81        | 99.94        | 100           | 99.87         | 98.92         | 97.62           | 99.87 |
| No. 8         | 2.36             | 97.40             | 89.57             | 96.44        | 98.77        | 99.98         | 98.65         | 94.43         | 93.72           | 95.77 |
| No. 16        | 1.18             | 92.47             | 70.92             | 86.57        | 90.37        | 99.55         | 97.52         | 84.75         | 82.35           | 86.54 |
| No. 30        | 0.60             | 86.95             | 55.95             | 71.96        | 77           | 95.75         | 88.25         | 74.42         | 70.86           | 77.23 |
| No. 50        | 0.30             | 65.87             | 33.43             | 39.37        | 60.62        | 79.35         | 72.24         | 48.2          | 45.33           | 52.21 |
| No. 100       | 0.15             | 10.03             | 12.82             | 3.52         | 18.35        | 16.42         | 17.34         | 5.51          | 4.54            | 6.34 |
| No. 200       | 0.075            | 2.200             | 5.82              | 0.53         | 5.71         | 3.66          | 4.18          | 0.85          | 1.85            | 0.55 |

For grading charts, the results of the filter analysis test on samples from Garuda Sakti 1, Garuda Sakti 2, Garuda Sakti 3, Pandau 1, Pandau 2, Pandau 3, Teratak Buluh 1, Teratak Buluh 2, Teratak Buluh 3, can be seen in Figure 3.
Based on Figure 3 shows that the results of the filter analysis test occur a quite significant gradation distribution, to determine the type of gradation good or bad must meet the statement that is the value of Cu > 6 for sand and the value of 1 > Cu < 3 for the type of grading sand is good. Cu and Cc values were obtained based on D10, D30, D60 data from the filter analysis results graph as shown in Figure 4. For the calculation of each sample as shown in Table 2.

From Figure 4, show that how to get the Cu and Cc values based on the filter analysis results obtained using D10, D30, D60 data, for further calculation data for the third Quarry sample can be seen in Table 2.
Based on the data obtained in table 2, the Puarau Quarry sample is a good gradation sand soil while the Garuda Sakti Quarry sample and other reed Teratak are poorly graded soils. Gradation of good pandau samples causes difficulty in the sandy soil to pass water so that the water content is quite high compared to samples from Garuda Sakti quarry and Buluh Teratak. Therefore, treatment or repairs need to be done so that the sandy soil can be used construction material. The graded sand soils have smaller pores than gap graded soils and uniformly graded soils, so well-graded soils are difficult to pass water [19].

Table 2. Summary of calculation results for Cu and Cc.

| No | Sample             | D10 | D30 | D60 | Cu   | Cc   | Nature of Gradation |
|----|--------------------|-----|-----|-----|------|------|---------------------|
| 1  | Garuda Sakti 1     | 0.16| 0.2 | 0.28| 1.75 | 0.8929| Bad Gradation       |
| 2  | Garuda Sakti 2     | 0.11| 0.28| 0.65| 5.91 | 1.0965| Bad Gradation       |
| 3  | Garuda Sakti 3     | 0.18| 0.23| 0.46| 2.56 | 0.6389| Bad Gradation       |
| 4  | Pandau 1           | 0.11| 0.28| 0.67| 6.09 | 1.0638| Fine Gradation      |
| 5  | Pandau 2           | 0.09| 0.23| 0.56| 6.22 | 1.0496| Fine Gradation      |
| 6  | Pandau 3           | 0.08| 0.35| 0.88| 11.00| 1.7401| Fine Gradation      |
| 7  | Teratak Buluh 1    | 0.16| 0.22| 0.40| 2.50 | 0.7563| Bad Gradation       |
| 8  | Teratak Buluh 2    | 0.22| 0.83| 0.45| 2.05 | 6.9586| Bad Gradation       |
| 9  | Teratak Buluh 3    | 0.14| 0.23| 0.37| 2.64 | 1.0212| Bad Gradation       |

4. Conclusion

Based on the results of testing in the laboratories of the three Quarries namely Garuda Sakti, Pandau and Tarak Buluh. The results obtained are the Puarau Quarry sample which is a good gradation of sand while the Garuda Sakti Quarry sample and other reed Teratak are poorly graded soils. Gradation of good pandau samples causes difficulty in the sandy soil to pass water so that the water content is quite high compared to samples from Garuda Sakti and Teratak Buluh quarries.

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