Porosity Analysis of Limestone in the South Leato Region of Gorontalo City

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Abstract. The research location is in South Leato, Gorontalo City. Geologically, the study site conditions are arranged in a dominant lithology of volcanic rock and limestone. The existence of limestone is interesting to study because its position in the hills shows a strong tectonic influence. The purpose of this study was to analyze the porosity of the limestone in the South Leato Region, Gorontalo City. This goal will be achieved using two methods: geological field surveys and laboratory analysis of specific gravity and water absorption tests of coarse aggregate. The results showed that the limestone that made up the research area was coralline rudstone. Referring to the average porosity value of the limestone in the study area, the porosity is excellent.

1 Introduction

Carbonate rock is formed from the remains of marine or terrestrial life or the result of water precipitation through various chemical and biochemical processes containing the elements Ca, C, and O to form $CaCO_3$. Because it is formed from elements of life, these rocks are generally rich in fossils, especially coral and algae, foraminifera and so on. In the field, these rocks are easily recognized because of their reactivity to hydrochloric acid (HCl). These rocks are distinguished from siliciclastic sedimentary rocks based on their chemical composition, mineralogy and texture. Carbonate rocks are chemical/biochemical sedimentary rocks that are very common on the earth's surface.

Carbonate rocks can be divided based on their mineral composition into limestone and dolomite. Limestone is composed mainly of the mineral calcite while dolomite is composed mainly of the mineral dolomite. During the earth's history, sedimentary rocks were composed of between 20-25% carbonate rocks which began to emerge from the Precambrian to the present (Quaternary) [1]. Based on its dominance, dolomite is very common in the Precambrian – Paleozoic, while limestone has been dominant since the Mesozoic until now.

The potential for limestone (carbonate rock) in Indonesia is enormous and spread almost evenly throughout the archipelago. There needs to be factual data about the number of limestone resources. However, based on its geological map, the potential for limestone in Indonesia is estimated to be around 28.678 billion tons [2]. This potential consists of approximately 61.376 million tons of indicated resources and 28.616 billion tons of inferred resources, including resources classified as speculative and hypothetical.

The potential for limestone in Gorontalo City is enormous. The magnitude of this potential provides excellent opportunities for developing and utilizing limestone in the future. The possibility that it is owned is not only from the industrial side but also from the environmental sustainability side, especially in mitigating the dangers of natural geological disasters [3,4,5].

Porosity measures the volume in the rock available to accommodate the reservoir fluids. Therefore, the importance of oil, gas, and water in a reservoir depends on porosity. Porosity (ϕ) is the ratio of the space in the rock (pore volume) to the total bulk volume of the stone [6]. Porosity in limestone results from many processes, both deposition and after deposition. Porosity in carbonate reservoirs ranges from 1% to 35%. Understanding the process and history of porosity texture is necessary to know the history of rocks and is essential for the potential of reservoir rocks. Several main mechanisms produce or change porosity and pore size distribution in carbonate rocks [7,8].

This research is focused on the porosity of the limestone. Previous studies regarding the porosity of limestone in Gorontalo have been carried out using petrographic analysis. Meanwhile, for this research, specific gravity tests and coarse aggregate water absorption were analyzed. The distribution of limestone in southern Gorontalo and the central part of Lake Limboto is very unique because it is among the dominant volcanic rocks [9,10,11,12]. Referring to this background, the research objective raised is to analyze the characteristics of the limestone on the South Coast of Gorontalo based on weight testing type and water absorption of coarse aggregate.

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2 Research Material and Methods

2.1 Research Material

The research material is limestone in South Leato Village, Dumbo Raya District, Gorontalo City. The research location is a plateau (hills) at the coordinates ST 1 (N 0º28'48.46", E 123º05'14.10") and ST 2 (N 0º29'05.06", E 123º05'11.03") (Figure 1).

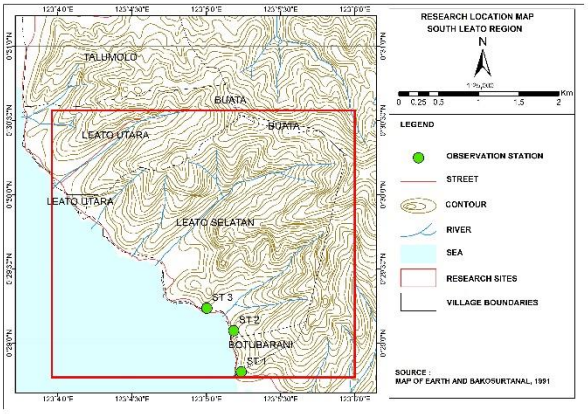

Fig. 1. The Research Location is in the South Leato area of Gorontalo City

2.2 Research Method

There were two research methods: geological field surveys and laboratory analysis. Field geological surveys in the form of sampling limestone for analysis in the laboratory and petrological analysis [9,10,11,12,13]. For petrological analysis, a complete description of the limestone in the study location starts from the texture, structure, and composition of the rock so that the name of the limestone can be determined in detail using classification [14]. At the same time, laboratory analysis is in the form of tests of specific gravity and water absorption of coarse aggregate [15,16,17,18]. Analysis of particular gravity and water absorption tests for coarse aggregate was carried out at the Laboratory of Soil Mechanics, Faculty of Engineering, State University of Gorontalo (Figure 2). The tools used for laboratory analysis of specific gravity and water absorption tests for coarse aggregate refer to [15] consisting of :

- Scales, with an accuracy of 0.1% and equipped with equipment to hang the test sample container in water in the middle of the weighing.
- Test sample container, namely a wire basket with a size of 3.35 mm or adjusting the test sample size.Tangki air, yakni tangki air yang kedap air.
- The hanging device is the wire used to hang the container and test sample.
- Cups, test sample containers when baked and soaked.
- Oven, with adjustable heat at (110+-5)°C.

Fig. 2. One of the stages in the specific gravity and water absorption test of coarse aggregate

3 Result and Discussion

The field survey results show that the outcrop is limestone composed of coarse grains with a massive structure. The description shows white limestone, component texture supported, grain size above 2 mm, poor sorting, open packaging and cavities in the limestone. Limestone has undergone a diagenetic process after being deposited with a composition of coral fragments and micrite. Based on the description of these rocks, it can be interpreted that the name of the rock is coralline rudstone [14] (Figure 3).

Fig. 3. Limestone Outcrops on the Cliffs of the South Leato Hills, Gorontalo City

After knowing the name of the rock is coralline rudstone, the next sample is analyzed in the laboratory. The results of laboratory analysis of specific gravity and water absorption tests for coarse aggregate on coralline rudstone are shown in Table 1. Complete data starting from the value of dry sample weight, surface dry saturated sample weight (SSD) and sample weight in water are presented in Table 1 so that the average value is known. . Table 1 is the result of measurements on samples at ST 1 and ST 2.

Table 1. Laboratory analysis measurement results on coralline rudstone samples at ST 1 and ST 2.

Number	Unit	ST 1	ST 2	Average
Dry sample weight	[A] Gram	258.95	185.00	221.98
Saturated Sample weight	[B] Gram	289.37	209.68	249.53
Surface Dry (SSD)	[C] Gram	144.55	103.11	123.83

Based on the measurement results on the ST 1 and ST 2 samples in Table 1, a calculation is then carried out using the existing formula. This calculation is carried out to determine the value of bulk specific gravity, surface dry saturated specific gravity (SSD), apparent specific gravity (apparent) and absorption (absorption). The formulas used in calculating the specific gravity are referred to [15] presented in Table 2.

Table 2. Laboratory analysis measurement results on coralline rudstone samples at ST 1 and ST 2.

Inspection Number	Formula
Bulk Density	$\frac{(A)}{(B)-(C)}$
Surface Saturated Specific Gravity (SSD)	$\frac{(B)}{(B)-(C)}$
Apparent Specific Gravity	$\frac{(A)}{(A)-(C)}$
Absorption	$\frac{(B)-(A)}{(A)} \times 100\%$
Porosity	$\frac{(B)-(A)}{(B)-(C)} \times 100\%$

Based on the formulas in Table 2, the average values of bulk specific gravity, surface dry saturated specific gravity (SSD), apparent specific gravity, absorption and porosity can be determined. The calculation results are presented in Table 3.

Table 3. Results Calculation of bulk specific gravity, surface dry saturated specific gravity (SSD), apparent specific gravity and absorption and porosity of *coralline rudstone* samples at ST 1 and ST 2.

Number	Unit	ST 1	ST 2	Average
Bulk Density		1.79	1.74	1.76
Surface Saturated Specific Gravity (SSD)		2.00	1.97	1.98
Apparent Specific Gravity		2.26	2.26	2.26
Absorption	%	11.75	13.34	12.54
Porosity	%	21.005	23.158	22.081

Based on Table 3, it can be analyzed that the porosity value of the limestone at ST 2 is higher than the porosity value of the limestone at ST 1. However, the average value of the porosity of the limestone at the study site is 22.081%. Referring to the average value of the porosity, the limestone in the research area refers to the classification [19] which is classified as very good porosity at intervals of 20-25%.

4 Conclusion

Based on the results and discussion in the limestone porosity analysis study in the South Leato area of Gorontalo City, essential conclusions can be drawn. First, the limestone in the research area is coralline rudstone. Second, referring to the average porosity value of the limestone in the study area, the porosity is very good at intervals of 20-25%.

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