



Limestone Characteristics as a Construction Material in Kabonga Besar and Surrounding Area of Donggala Regency of Central Sulawesi Province

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Abstract. The continuous growth of population increases the demand for housing and infrastructure, posing challenges in providing sustainable and environmentally friendly construction materials. Limestone, a non-metallic mineral commodity, holds significant potential as a construction material. However, its lithological variations and mechanical properties require further analysis to determine its suitability. Widespread limestone deposits are found on both sides of Palu Bay, with significant occurrences in the Banawa area (west) and from northern Enu to west of Labean (east). This study investigates limestone lithological characteristics and variations using three methods: megascopic observation, petrographic analysis, and compressive strength testing. Megascopic observation identified lithological variations such as calcarenite, while petrographic analysis revealed microscopic variations, including dismicrite, biomicrite, fossiliferous micrite, and oomicrite. Compressive strength tests yielded values ranging from 7.41 kg/cm² to 326.84 kg/cm². The findings indicate that higher ooid composition in limestone results in lower compressive strength, whereas higher bioclast composition corresponds to increased compressive strength. These results align with Kamran et al. (2022), who highlight the significant influence of ooid, peloid, and bioclast components on the geomechanical properties of limestone. Based on compressive strength values, limestone in the study area is suitable for use as plaster or decorative stone.

Keywords: Compressive strength, Construction, Limestone

1 Introduction

The availability of limestone in Central Sulawesi is quite significant, with extensive distributions on both sides of Palu Bay. On the western side, it is found in the Banawa area and its surroundings, while on the eastern side it stretches from the northern part of Enu to the western side of Labean (Sukanto, 1973). The utilization of limestone remains very limited, especially as a construction material, while the continuously growing population has increased the demand for housing and infrastructure. Therefore, sustainable construction materials that are available in adequate quantities are needed to support future development.

Limestone is one of the non-metallic mineral commodities that can be used as

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construction material, such as for house foundations, road paving, concrete aggregates, and sidewalks (Sukandarrumidi, 2016 in Zaenuri et al., 2018). Limestone possesses strong, durable, and environmentally friendly properties. Thus, it is an appropriate choice for use in the construction of various types of buildings. To be utilized effectively, the mechanical properties of the rock, particularly its resistance to building loads, need to be analyzed first (Botjing et al., 2022; Sembiring and Juliani, 2014). In this regard, the composition of limestone also affects its mechanical properties (Kamran et al., 2022).

A more detailed study on the mechanical properties testing of limestone in this area is interesting to conduct to provide reference data for its utilization and further development in the surrounding region. The distribution of limestone in the Kabonga Besar area of Donggala Regency is extensive and varied, making it a promising area for exploitation as a mineral resource. This serves as the basis for studying the characteristics of limestone as a construction material in the Kabonga Besar area of Donggala, Central Sulawesi.

2 Research Methods

2.1 Research Location

Administratively, the research location is included in the Kabonga area and its surroundings, Banawa District, Donggala Regency, Central Sulawesi Province. Geographically, the research location is situated at 119°42'00" - 119°45'30" E and 00°40'00" - 00°43'00" S. The research location is mapped in the topographic maps of Indonesia sheets Tavaili 2015-34 and Donggala 2015-33 at a scale of 1:50,000, published by Bakosurtanal, edition 1, 1991, Cibinong Bogor (see Fig 1).

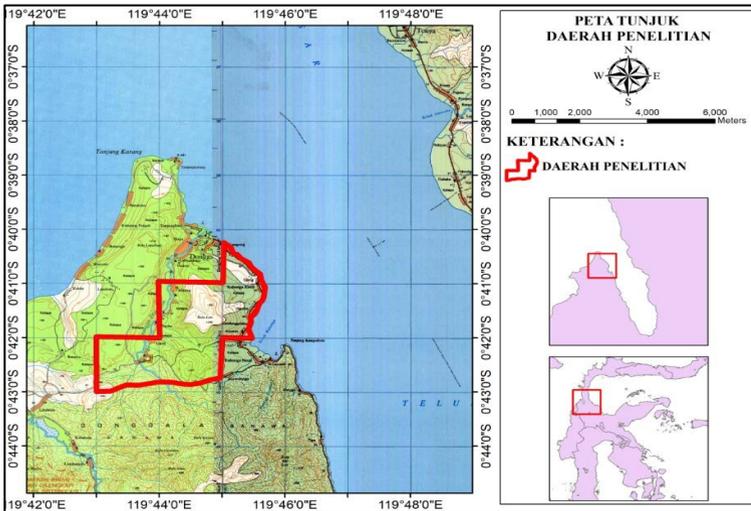


Fig.1. Research Area Map

2.2 Data Collection

Data collection involved direct field data acquisition. The field data refers to geological data of the research area, including outcrop data which encompasses lithological data, geomorphological data, and geological structure data. The lithological data collection involves observing the physical conditions of the rocks directly in the field and the characteristics of limestone in the research area, as well as collecting rock samples for laboratory analysis. The geomorphological and structural data serve as supporting information. Rock samples are selected based on their freshness and good exposure. The results of the laboratory analysis are then integrated with the supporting data to draw conclusions about the characteristics of limestone as a construction material.

2.3 Data Processing

Petrographic Analysis and Rock Compressive Strength Testing

After the field data collection process, laboratory analysis is then conducted. The field data to be analyzed consists of rock samples. The first step is the selection and separation of the rock samples to be used in laboratory analysis. The analyses performed include petrographic analysis and compressive strength testing. Petrographic analysis is applied to the lithological samples to determine the mineral content and constituent materials in the rocks, which helps in understanding the characteristics and classification of the rocks. The compressive strength test aims to assess the rock's resistance to building loads and the quality of the limestone.

Determination of Limestone Potential as a Construction Material

The potential of limestone as a construction material, based on its characteristics, is determined by laboratory analysis results and supporting field data, namely:

1. Petrographic analysis is conducted on lithological samples to determine the mineral content and constituent materials in the rocks, which helps identify the characteristics and classification of the rock
2. Laboratory analysis for compressive strength testing is performed to assess the rock's resistance to building loads.

3 Result and Discussion

Field observations and data collection were conducted in the Kabonga Besar area, comprising 15 stations (see Fig 2).

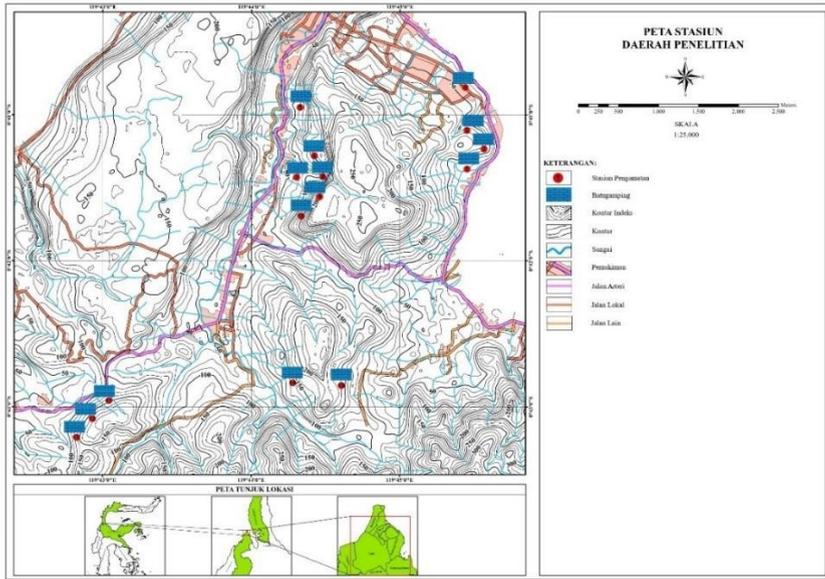


Fig. 2. Map of Data Collection Stations

All observation stations generally exhibit similar physical characteristics, namely, macroscopically, the rocks found in fresh condition are white, while the weathered color is dark gray. The material composition consists of calcite minerals, with a bioclastic texture, poor sorting, open packing, and grain sizes ranging from fine sand to coarse sand. Several large foraminifera fossils and corals were also found. The rock is classified as calcarenite (see Fig 3).



Fig. 3. Limestone outcrop with photo taken at N205°E

Based on the petrographic observations (see Fig. 4) and the rock compressive strength tests conducted on 15 samples, the data is presented in Table 1.

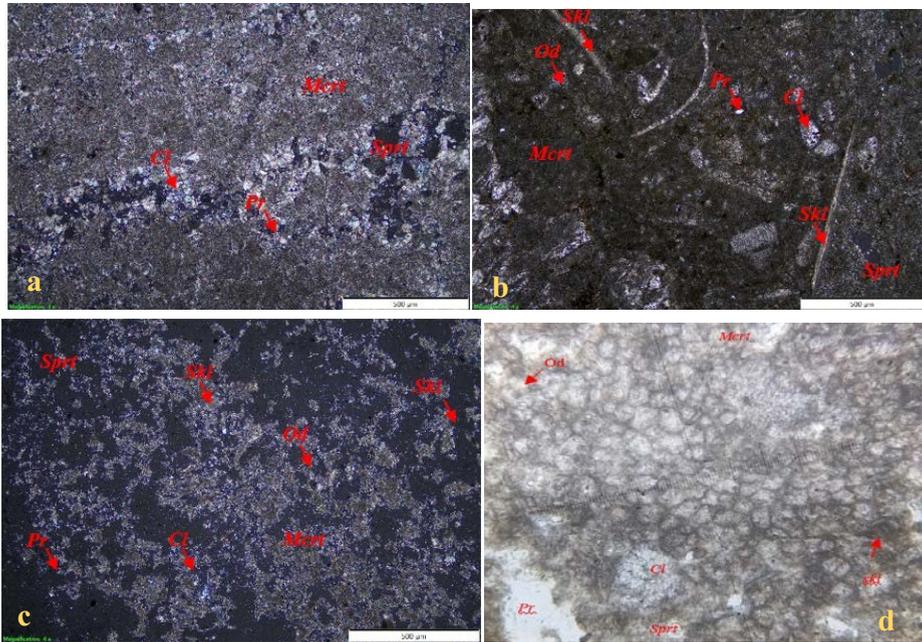


Fig. 4. Microscopic features of limestone a. Dismicrite, b. Biomicrite, c. Fossiliferous micrite, d. Oomicrite

Table 1. Percentage of Rock Components and Compressive Strength Value

No	Kode Sampel	Percentage Composition of Material (%)				Kuat Tekan (Kg.f/cm)
		Ooid %	Bioclast (Foramini fera + Alga)	Kalsit (Kalsit + Mikro Kristalin Kalsit + Spari Kalsit)	Pori	
1	01/TF/DIPA	0	0	90	10	18.86
2	02/TF/DIPA	8	40	42	10	244.98
3	03/TF/DIPA	10	35	45	10	79.31
4	04/TF/DIPA	45	10	35	10	7.41
5	05/TF/DIPA	5	55	35	5	326.84
6	06/TF/DIPA	0	20	75	5	20.60
7	07/TF/DIPA	0	10	85	5	19.62
8	08/TF/DIPA	2	5	87	6	18.50
9	09/TF/DIPA	0	0	95	5	9.04
10	10/TF/DIPA	0	0	95	5	8.16

11	11/TF/DIPA	0	0	90	10	38.46
12	12/TF/DIPA	10	30	55	5	243.80
13	13/TF/DIPA	8	27	60	5	170.10
14	14/TF/DIPA	10	25	60	5	128.33
15	15/TF/DIPA	10	20	65	5	41.95

Based on the table above, it shows that the ooid component in limestone has a poor relationship with compressive strength, where the higher the percentage of ooid in the limestone, the lower the compressive strength value, which is

7.41 kg.f/cm² with 45% ooid content. In contrast, the limestone with a higher percentage of bioclast composition has a higher compressive strength value of 326.84 kg.f/cm² with 45% bioclast content (see Fig 5). According to SNI 03- 0394-1989 and Dirjen cipta karya PUPR (1982), in Table 1, based on the obtained data, the samples that meet the specifications for building materials are those with the codes 02/TF/DIPA, 05/TF/DIPA, and 12/TF/DIPA, with values of 244.98 kg.f/cm², 326.84 kg.f/cm², and 243.80 kg.f/cm², which can be utilized as ornamental stone or wall stone.

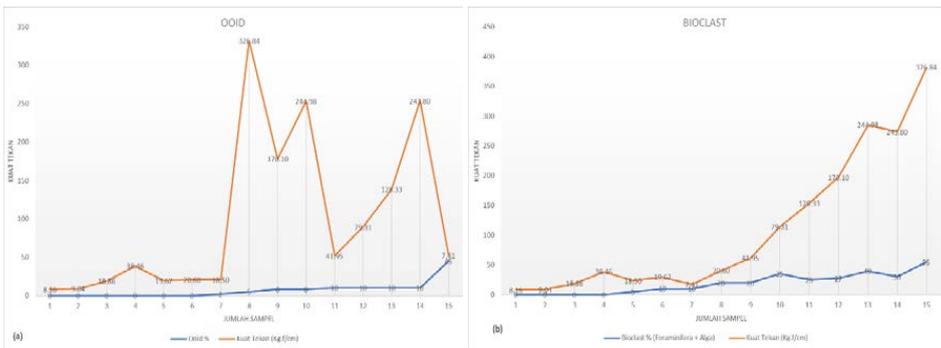


Fig. 5. Graph (a) Relationship between Compressive Strength and Ooid, (b) Relationship between Compressive Strength and Bioclast.

Based on the data above, it can be concluded that the relationship between ooid and bioclast components can influence the compressive strength. This is in line with the theory proposed by Kamran et al. (2022), which states that limestone, consisting of ooids, peloids, and bioclasts, significantly affects its geo-mechanical properties.

4 Conclusion

- 4.1 The type of limestone in the research area, observed macroscopically based on the classification of Grabau (1904), is classified as calcarenite. Microscopically, based on the classification of Folk (1962), there are four types: dismicrite, fossiliferous micrite, biomicrite, and oomicrite.
- 4.2 According to SNI 03-0394-1989 and the Directorate General of Human Settlements, PUPR (1982), as presented in Table 1, for utilization in the construction sector based on the obtained data, the samples that meet the specifications for building materials are those with the codes TF/DIPA2, TF/DIPA5, and TF/DIPA12, with compressive strength values of 244.98 kg.f/cm², 326.84 kg.f/cm², and 243.80 kg.f/cm², which can be utilized as ornamental stone or wall stone.

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