NASKAH PUBLIKASI *(MANUSCRIPT)*

PEMERIKSAAN KEKUATAN BATU DARI KUARI DI KOTA SAMARINDA UNTUK AGREGAT KASAR BETON

STRENGTH EXAMINATION OF STONE FROM QUARRY IN SAMARINDA CITY FOR COARSE CONCRETE AGGREGATE

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STUDY OF COMPRESSIVE STRENGTH CHARACTERISTICS OF SAMARINDA LOCAL STONE TO ACHIEVE STRUCTURAL CONCRETE CONDITIONS

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Abstract

Infrastructure development is rapidly growing in East Kalimantan due to the construction of the Indonesian National Capital in North Penajam Paser Regency, requiring increased materials. The buffer zone preparation, including the borders of North Penajam Paser, Balikpapan, Samarinda, and Kutai Kartanegara, plays a vital role in the construction of the State Capital in North Penajam Paser Regency, East Kalimantan Province. Local stone measures 60.78 MPa, Cermin stone measures 49.18 MPa, and Besaung stone measures 32.48 MPa. Moreover, concrete made with the highest coarse aggregate, Suryanata showed strengths of 13.85 MPa at 7 days, 26.64 MPa at 14 days, and 16.50 MPa at 28 days. It is concluded that using Suryanata Quarry's coarse aggregate is not recommended for structural concrete but can be suitable for foundation work.

Keywords: Limestone, Coarse Aggregates, and Compressive Strength.

I. Introduction

The region in East Kalimantan has been officially designated as the new Capital City (Ibu Kota Negara, IKN) of the Unitary State of the Republic of Indonesia following the enactment of Law number 3 of 2022 concerning the new Capital City (Erwanti & Waluyo, 2022). The new Capital City is located in Penajam Paser Utara (PPU) districts and Kutai Kartanegara. Being a capital city rich in natural resources, it will not only serve as the government's administrative center but is also expected to experience an increase in population. Various sectors, including infrastructure, are expected to flourish in and around the capital city as it continues to develop (Nugroho, 2020).

The infrastructure development in East Kalimantan is rapidly advancing alongside construction of the new Capital City of Indonesia in Penajam Paser Utara Regency. As a result, there is an increasing demand for materials. Many materials, such as Palu stone and Palu sand, are imported from Sulawesi (Siregar, 2022). The preparation of the supporting areas around the new Capital City, including the borders of Penajam Paser Utara, Balikpapan, Samarinda, and Kutai Kartanegara, plays a crucial role in the development of the Capital City in Penajam Paser Utara, East Kalimantan Province (Sari, 2022). Therefore, it is essential to research to utilize the potential of local materials available in East Kalimantan Province. One of the areas with potential for rock mining is Samarinda City. Given the abundance of rock mining potential in Samarinda, researchers are drawn to examine the strength of the rocks in this area.

Rocks are natural materials composed of one or more minerals, either of the same or different kinds, bound together loosely or solidly (Tamanak, 2020). Rock is a natural, hard aggregate formed from accumulating and arranging one or more minerals. A mineral matrix in cement holds together several minerals that constitute a rock. The primary raw material present in the earth is rock. Rocks weather down to become soil and soil, which becomes the primary medium for plant growth and the habitat for various forms of life in the world.

Sedimentary rock is a type of rock that forms through the process of deposition of materials resulting from erosion or dissolution. Generally, sedimentary rocks have bright or light colors, such as white, yellow, or light gray. Regarding color, this greatly depends on the composition of the materials that make it up.

The research conducted by Aryaseta in 2022 with the title "Experimental Study of the Physical and Mechanical Properties of Limestone" resulted in several essential parameter values as follows: Compressional Wave Modulus (M) of 58.72 GPa, Bulk Modulus (k) of 19.57 GPa, and Shear Modulus (μ) of 29.36 GPa.

In this research, the researchers will conduct quality testing on local stones from three locations: Jl Suryanata in Bukit Pinang Village, Samarinda Ulu District; Jl Batu Cermin in Sempaja Utara Village, Samarinda Utara District; and Jl Batu Besaung in Sempaja Utara Village, Samarinda Utara District, in the city of Samarinda. These areas are rich in natural resources with abundant material production capacity. Being located not far from the center of Samarinda city and approximately 75 km away from the new Capital City (Ibu Kota Negara, IKN) with a travel time of about 2 hours, they have significant potential for supplying materials to support the construction needs of the new Capital City. Utilizing materials from these locations can help reduce material mobilization costs and minimize the risk of material distribution delays at the project sites (Abdi, 2019). The stones used as concrete materials will undergo various tests, including the compressive strength test, to determine their strength before being selected as coarse aggregates in concrete mixtures. Concrete is a solid mass formed by mixing Portland cement or hydraulic cement, fine aggregates, coarse aggregates, and water, with or without additional materials (SNI 03 - 2834 - 1993).

II. Methods

2.1 Research Location

The collection of materials is the initial stage of this research, where the author seeks stones to be used as the primary materials in the study. These stones are obtained from quarries in Air Putih Village on Jl Suryanata, Jl Batu Cermin, and Jl Batu Besaung Sempaja in Samarinda, East Kalimantan Province. Samarinda city covers an area of 718.00 km2, with coordinates ranging from 00º 19' 02" N to 00º 42' 34" N latitude and 117º 03' 00" E to 117º 18' 14" E longitude. It comprises 10 districts, traversed by the Mahakam River and its tributary, the Karang Mumus River, which divides the city of Samarinda. The population of Samarinda is approximately 928,644 inhabitants, with an annual population growth rate of 11%.

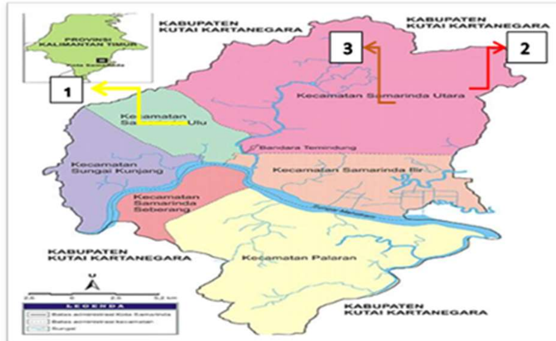


Figure 1. Maps of Samarinda City
Source: Research (2023)

The test specimens in this research were obtained from quarries located at three locations: Jalan Suryanata, Jalan Batu Cermin, and Jalan Batu Besaung in Samarinda. These can be seen in the images below, Figures 2, 3, and 4:

Figure 2. Suryanata Quarry Location
Source: Research (2023)

Figure 3. Cermin Quarry Location
Source: Research (2023)

Figure 4. Besaung Quarry Location
Source: Research (2023)

Information about quarries in Samarinda City.

• Suryanata Quarry
Suryanata Stone Quarry is located at coordinates 0.47498º S and 117.11736º E. The distance from Universitas Muhammadiyah Kalimantan Timur is approximately 3.7 km, which takes approximately 9 minutes to reach. This quarry is a significant source of stones and other materials used for various purposes, including the region's construction projects and industrial needs.
• Cermin Quarry
Cermin Stone Quarry is located at coordinates 0.42671º S and 117.13686º E. The distance from Universitas Muhammadiyah Kalimantan Timur is approximately 8.9 km, which takes approximately 17 minutes to reach. This quarry is an essential source of stones and other materials used for construction and industrial purposes in the area.
• Besaung Quarry
Besaung Stone Quarry is located at coordinates 0.40910º S and 117.14261º E. The distance from Universitas Muhammadiyah Kalimantan Timur is approximately 10 km, which takes about 20 minutes to reach. This quarry is also a significant source of stones and other materials used for various regional construction and industrial needs.

2.2 Planning of Stone Test Specimens

After conducting a site survey, intact stone samples were collected for performing physical property tests on the stones before they were cut into 5x5x5 cm and 10x10x10 cm, with three test specimens for each size from each location. Additional physical property tests were carried out once the samples were cut to the specified dimensions. Subsequently, mechanical property testing was conducted using a Compression Machine. The compressive strength values obtained from each test specimen were compared, and the highest compressive strength value was selected to be used as the material for the concrete mixture. Sampling, testing, and selecting the appropriate stone material for the concrete is essential to ensure the quality and performance of the concrete used in the research or construction project. The researchers aim to use the stone material with the highest compressive strength among the tested specimens to guarantee the durability and reliability of the resulting concrete.

In the planning stage of creating stone test specimens, the process involves transforming initial intact stone samples into cube shapes with specified dimensions. Nine test specimens are prepared with dimensions of 5 x 5 x 5 cm and another nine with dimensions of 10 x 10 x 10 cm, totaling 18 specimens. The variation of test specimens on the stones is planned and documented in Table 1 below :

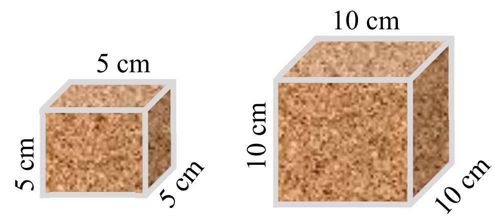


Figure 5. Stone Sample Planning
Source: Research (2023)

Table 1. Stone Test Specimen Planning

Test Specimens (cubes)	Compressive Strength Testing (size of test specimens)		Quantity Sample
	5 Cm	10 Cm	
Suryanata Quarry Stone	3	3	6
Cermin Quarry Stone	3	3	6
Besaung Quarry Stone	3	3	6
Total Test Specimens	9	9	18

Source: Research (2023)

2.3 Perencanaan Benda Uji Beton

The production of test specimens follows the guidelines of concrete mix design as per SNI 03-2834-2000 with a targeted compressive strength of 30 MPa. The test specimens are cylindrical with dimensions of 15 x 30 cm. A total of 9 test specimens are prepared in this study. Please refer to Table 2 below for more details:

Table 2. For concrete test specimen planning

Test Specimens (Cylinders)	Compressive Strength Testing (Concrete Age)			Quantity of Samples
Location	7 Days	14 Days	28 Days	
Stone from Suryanata Quarry	3	3	3	9

Source: Research (2023)

2.4 Concrete Mix Design Planning

In mix design using SNI 03-2834-2000, the first step is to consider the following parameters:

Concrete Strength (compressive strength) fc' 30 MPa, Coarse Aggregate Used Local crushed stone from Suryanata Quarry, Fine Aggregate Used Palu sand, Maximum Aggregate Diameter 20 mm, Type of Cement Used Type 1, Structure to be Constructed Road, Work Quality Moderate.

The concrete proportions for the three test specimens are obtained based on the mix design planning. The results can be seen in Table 3 below:

Table 3. For concrete mix proportions of the test specimens

Cement (kg)	Water (L)	Fine Aggregate (kg)	Coarse Aggregate (kg)
7,668	3,91	13,829	16,902

Source: Research (2023)

2.5 Concrete Test Specimen Preparation

Preparing the concrete test specimens will involve using a Concrete Mixer Machine to mix the materials according to the calculated mix design.

Figure 6. Concrete Mixer Machine
Source: Research (2023)

In making concrete test specimens, one mixer batch will create 3 test specimens, following the specified mix proportions and the designated testing age. Once the concrete production is completed, the test specimens are neatly arranged and labeled for identification.

In the concrete test specimen preparation, the concrete specimens for testing at different ages were made on the following dates:

1. Concrete specimens for 7-day testing were made on May 29, 2023, and will be tested on June 6, 2023.
2. Concrete specimens for 14-day testing were made on May 18, 2023, and will be tested on June 2, 2023.
3. Concrete specimens for 28-day testing were made on May 20, 2023, and will be tested on June 18, 2023.

2.6 Slump Test for Concrete

The Slump Test is conducted to determine the consistency of the concrete mix in the mixer before production to achieve the target compressive strength of 30 MPa. The Slump Test involves measuring the height of the concrete slump when it collapses from the height of the Abrams cone. This research sets the planned slump value between 60-180 mm. The measurement will be performed for each batch of concrete when preparing the test specimens (concrete cylinders)

Figure 7. Slump Test for Concrete
Source: Research (2023)

Table 4. Slump test of concrete specimens

No	**Concrete Age (Days)**	**Planned Slump (mm)**	**Obtained Slump Result (mm)**
1	7	60-180	105
2	14	60-180	95
3	28	60-180	95

Source: Research (2023)

The Slump Test results for the concrete obtained from Table 4, in consecutive order at 7 days, 14 days, and 28 days, are 105 mm, 95 mm, and 95 mm, respectively.

2.7 Weighing of Concrete Test Objects

The concrete weighing process is conducted after the concrete has dried and is ready for compressive strength testing, as shown in Figure 8 below.

Figure 8. Concrete Test Specimen Weighing
Source: Research (2023)

Table 5. Weight of Concrete Test Specimens

No	Concrete Age	Weight of Test Object (kg)	Average (kg)
1	7 Days	12,680	12,617
2		12,705	
3		12,465	
1	14 Days	12,705	12,630
2		12,505	
3		12,680	
1	28 Days	12,825	12,713
2		12,675	
3		12,640	

Source: Research (2023)

The average weight of the concrete test specimens at 7 days is 12.617 kg, at 14 days is 12.630 kg, and at 28 days is 12.713 kg. These weight values are essential for evaluating the density and strength properties of the concrete at different ages. The obtained data can be further used for analyzing the concrete's performance and adherence to the specified standards and requirements.

III. Result and Discussion

3.1 Data and Potential Yields from Quarries

- Suryanata Quarry

Visual direct observation of the location regarding the area assisted by using the Google Earth application by providing boundaries according to the coordinates of the quarry location so that an area of ± 53,918 m 2 can be obtained with an estimated average quarry height of 11 m.

- Cermin Quarry

Visual direct observation of the location regarding the area assisted by using the Google Earth application by providing boundaries according to the coordinates of the quarry location so that an area of ± 13,206 m 2 can be obtained with an estimated average quarry height of 10 m.

- Besaung Quarry

Visual direct observation of the location regarding the area assisted by using the Google Earth application by providing boundaries according to the coordinates of the quarry location so that an area of ± 18,688 m 2 can be obtained with an estimated average quarry height of 6 m.

3.2 Data and Test Results for the Physical Properties of Rocks

The results of the physical properties testing of stones from 3 quarries in Samarinda City can be seen in Table 6.

Table 6. Testing the physical properties of the rock

Quarry	Results of Physical Properties Testing				
	Specific gravity	Absorption (%)	Volume Weight	Water content (%)	Abrasion (%)
Suryanata	2,485	0,959	2,721	0,45	26,68
Cermin	2,411	0,955	2,710	0,69	35,1
Besaung	2,490	1,133	2,578	0,818	28,5

Source: Research (2023)

Stones from the Suryanata quarry get an average abrasion yield of 26.68%, an average specific gravity of 2.485, and absorption of 0.959%. While the average volume weight is 1.722 kg/cm 2, and the average moisture content obtained is 0.45%.

Stones from the Cermin quarry get an average abrasion yield of 35.1%, an average specific gravity of 2.411, and an average absorption of

0.955%. While the volume weight obtained was an average of 1.683 kg/cm 2, and the average water content obtained was 0.69%. The stone from the Besaung quarry has an average abrasion yield of 28.5%, an average specific gravity of 2.490, and an average absorption of 1.133%. While the volume weight obtained was an average of 1.812 kg/cm 2, and the average water content obtained was 0.818%.above.

Figure 9. Measurement of the dimensions of a 5cm stone test object
Source: Research (2023)

Figure 10. Abrasion testing
Source: Research (2023)

3.3 Data and Test Results for the Mechanical Properties of 5 Cm Stone

After the stone is cut into cubes of 5x5x5 cm, mechanical testing is carried out using a concrete compressive strength tool. So that it can be written using the formula according to SNI 1974-2011 as follows:

Cross-sectional Area = Side × Side
= 5 × 5
= 25 Cm²

Test data obtained by BS 1 test objects :
Compressive strength value (MPa)

$$= \frac{Press\ Load\ (N)}{Cross-sectional\ area}$$

$$= \frac{317,100}{28,30}$$

= 42.68 MPa

Conversion of specimens 15 x 15 cm

$$= \frac{Average\ compressive\ strength (Mpa)}{Correction\ figure}$$

$$= \frac{68,80}{1,06}$$

= 64.90 MPa

Table 7. Results of the 5 cm stone compressive strength test

Sample Code		Dimensions (Cm)	Cross-sectional area	Dial Reading (kN)	Press Load (N)	Compressive Strength (Mpa)	Average (Mpa)
BS (Suryanata)	1	5,32	28,30	120,8	120800	42,68	68,80
	2	5,05	25,50	306,2	306200	120,07	
	3	5,35	28,62	124,9	124900	43,64	
BC (Cermin)	1	5,03	25,30	69,4	69400	27,43	46,77
	2	5,15	26,52	165,4	165400	62,36	
	3	4,98	24,80	125,3	125300	50,52	
BB (Besaung)	1	4,98	24,80	71,7	71700	28,91	35,53
	2	5,23	27,35	128,6	128600	47,02	
	3	5,06	25,60	78,5	78500	30,66	

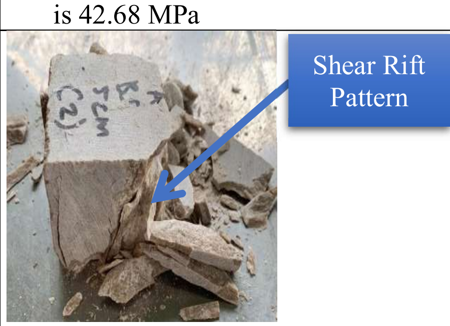
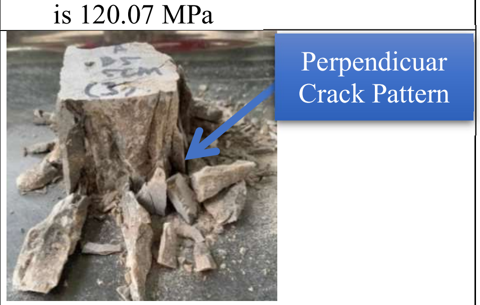
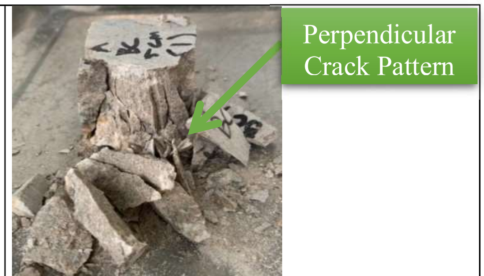
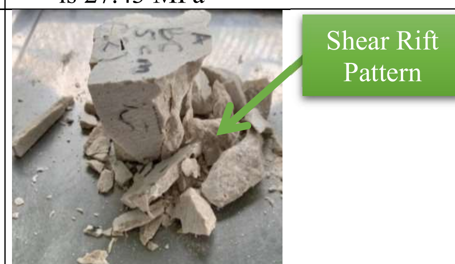
Source: Research (2023)

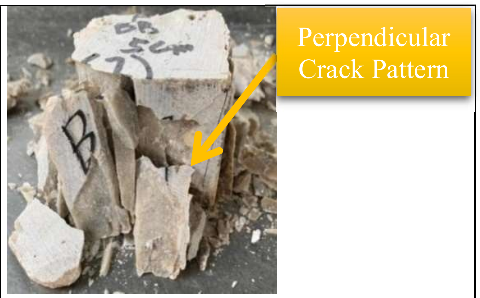
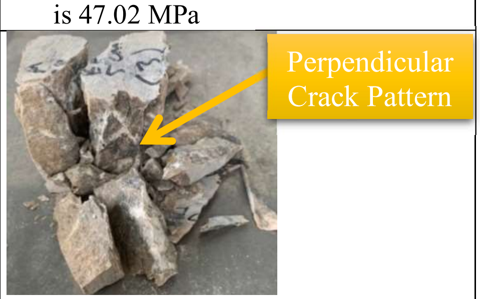
The results of the 5 cm stone compressive strength test can be seen in Table 7. The highest results were found in the Suryanata quarry, with an average compressive strength value of 68.80 MPa. The Cermin quarry has an average compressive strength value of 44.12 MPa; in the Besaung quarry, the lowest average compressive strength is 35.53 MPa. This strong result becomes the basis for determining the coarse aggregate that will be made of concrete specimens.

Figure 11. 5 cm stone specimen
Source: Research (2023)

A. Ruin Pattern

Table 8. The pattern of failure of 5 cm rock specimens

Code	5cm Size Test Object Model
BS (1)	 Suryanata Sample Test Objects (1) - It has a gray visual color - Destruction after thorough testing - Split into pieces - The resulting compressive strength is 42.68 MPa
BS (2)	 Suryanata sample specimens (2) - Has a bright white visual color - The destruction after testing was not thorough - Small pieces - The resulting compressive strength is 120.07 MPa
BS (3)	 Suryanata sample specimens (3) - It has a gray-white visual color - Destruction after being tested is not complete - Small pieces - The resulting compressive strength is 43.64 MPa
BC (1)	 Cermin sample specimens (1) - It has a gray-white visual color - The destruction after testing was not thorough - Small pieces - The resulting compressive strength is 27.43 MPa
BC (2)	 Cermin sample specimens (2) - Has a bright white visual color - Destruction after thorough bottom testing - Small pieces - The resulting compressive strength is 62.36 MPa
BC (3)	 Cermin sample specimens (3) - Has a bright white visual color - Destruction after being tested is not complete - Small pieces - The resulting compressive strength is 50.52 MPa

BB (1)	 Besaung sample specimens (1) - Has a bright white visual color - Destruction after thorough testing - Small pieces - The resulting compressive strength is 28.91 MPa
BB (2)	 Besaung sample specimens (2) - It has a dark gray visual color - The destruction after testing was not thorough - Small pieces - The resulting compressive strength is 47.02 MPa
BB (3)	 Besaung sample specimens (3) - dark gray visual color - The destruction after testing was not thorough - Small pieces - The resulting compressive strength is 47.02 MPa

Source: Research (2023)

The fracture pattern in the rock from Suryanata Quarry, Cermin Quarry, and Besaung Quarry, specimens 1 and 3 with a 5 cm specimen model, is a perpendicular pattern or dominant in compression failure, while in specimen 2 is a shear pattern or dominant in tensile failure. Based on visual observations, it was found that the rock destruction characteristics reached 70% in the BB 3 specimen (5 cm). More details can be seen in Table 8 above.

Table 9. Destruction of 5 cm rock specimens

Location	Specimens	Rock Crushing (%)	Compressive Strength (Mpa)
Suryanata	1	80%	42.68
	2	30%	120.07
	3	20%	43,64
Cermin	1	60%	27,43
	2	40%	62,38
	3	50%	50,52
Besaung	1	40%	28,91
	2	30%	47.02
	3	70%	30,66

Source: Research (2023)

It can be concluded that the greater the percentage of destruction in the specimen, the more brittle rock characteristics are unrelated. This relates to the location of the samples taken. Many specimens containing sand were found during rock collection in Suryanata Quarry, Cermin Quarry and Besaung Quarry. Can be seen in Table 9 above.

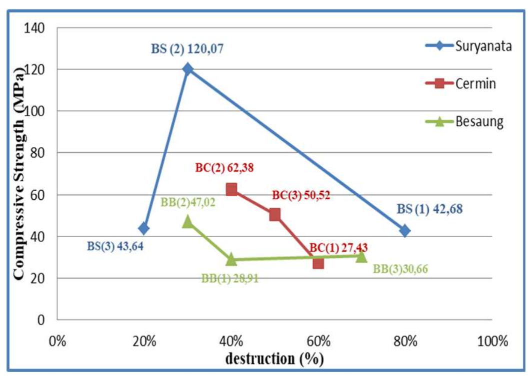


Figure 12. Graph of 5 cm specimen collapse
Source: Research (2023)

It can be seen in Figure 12 that the relationship between high rock crushing rates is not always low compressive strength, while low rock crushing is not always high compressive strength. Then the stone has a high sand content, so the stone can be considered not solid.

3.4 Data and Test Results for the Mechanical Properties of 10 Cm Stone

After the stone is cut into cubes of 10x10x10 cm, mechanical testing is carried out using a concrete compressive strength tool.

Cross-sectional Area = Side × Side

= 10 × 10

= 100 Cm²

From the test data obtained, sample BS 1:

Compressive strength value (MPa)

$$= \frac{Press\ Load\ (N)}{Cross{-}sectional\ area}$$

$$= \frac{446{,}700}{106{,}1}$$

= 42.11 MPa

Conversion of specimens 15x15 cm

$$= \frac{Average\ compressive\ strength (Mpa)}{Correction\ figure}$$

$$= \frac{52{,}76}{1{,}03}$$

= 51 .22 MPa

Table 10. Results of the compressive strength test of 10 cm dimension stone

Sample Code		Dimensions (Cm)	Cross-Sectional Area	Dial Reading (kN)	Press Load (N)	Compressive Strength (MPa)	Average (Mpa)
BS (Suryanata)	1	10,3	106,1	446,7	446700	42,11	52,76
	2	10,2	104,0	601,1	601100	57,78	
	3	10	100,0	583,9	583900	58,39	
BC (Cermin)	1	10,4	108,2	553,3	553300	51,16	51,58
	2	10,3	106,1	559,5	559500	52,74	
	3	10,3	106,1	539,5	539500	50,85	
BB (Besaung)	1	9,8	96,0	264,7	264700	27,56	29,42
	2	10,5	110,3	182,8	182800	16,58	
	3	10,7	114,5	505,1	505100	44,12	

Source: Research (2023)

The results of the 10 cm stone compressive strength test can be seen in Table 10. The highest results were obtained in the Suryanata quarry with an average compressive strength value of 52.76 MPa. In the Besaung quarry, the lowest average compressive strength value was 29.42 MPa; in the Cermin quarry, the average compressive strength was 51.58 MPa. These results compare the compressive strength test of 5cm stones as a determinant of the use of coarse concrete aggregate.

Figure 13. Stone specimen 10 cm
Source: Research (2023)

Table 11. Conversion of 15 cm stone specimens

Quarry	Sample		Average (MPa)
	5x5x5cm (MPa)	10x10x10cm (MPa)	
Suryanata	68,80	52,76	60,78
Cermin	46,77	51.58	49,18
Besaung	35,53	29,42	32,48

Source: Research (2023)

Based on the results in Table 11, it is known that the average compressive strength at each location is the highest compressive strength from the Suryanata quarry at 60.78 MPa, the second compressive strength from the cermin quarry is 49.18 MPa, and the lowest compressive strength is from Besaung quarry of 32. 48 MPa.

3.5 Concrete Testing Data and Results

Based on SNI 03-1974-1990, the compressive strength test of concrete can be obtained using the following formula :

Cross-sectional Area $= \pi \times r^2$

$= 22/7 \times (7{,}5)^2$

$= 176{,}786\ cm^2$

$= 17678{,}6\ mm^2$

From the test data obtained:

Sample BS 1 aged 7 days (MPa)

$$= \frac{Dial\ reading\ (kN) \times 1000\ (N)}{Cross{-}section\quad area}$$

$$= \frac{317{,}1 \times 1000}{17678{,}6}$$

= 17.94 MPa

Figure 14. Testing concrete specimens
Source: Research (2023)

Table 14. Results of concrete compressive strength test

No	**Cross-Sectional Area (cm²)**	**Dial Reading (kN)**	**Compressive Strength (Mpa)**
7 Days Age Testing			
BS 1	17678.6	317,1	17.94
BS 2		202.9	11.48
BS 3		214,3	12,12
Average		244.8	13.85
14 Days Age Testing			
BS 1	17678.6	438,1	24.78
BS 2		460.3	26.04
BS 3		514.4	29,10
Average		470.9	26,64
28 Day Age Testing			
BS 1	17678.6	355,2	20.09
BS 2		243,1	13.75
BS 3		277.0	15,67
Average		291.77	16.50

Source: Research (2023)

Based on the concrete compressive strength test, it can be seen in Table 14 that at the age of 7 days, the average value obtained was 244.8 kN or 13.85 MPa. At 14 days, the average compressive strength was obtained with a value of 470.9 kN or 26.64 MPa; at 28 days, the average compressive strength was 291.77 kN or 16.50 MPa. Based on SNI 6880-2016, concrete can be used as structural concrete if the minimum compressive strength of concrete is 17 MPa, while concrete with compressive strength below 17 MPa cannot be used as structural concrete.

Figure 15. Concrete test specimen before being tested
Source: Research (2023)

Figure 16. Concrete specimens, after being tested
Source: Research (2023)

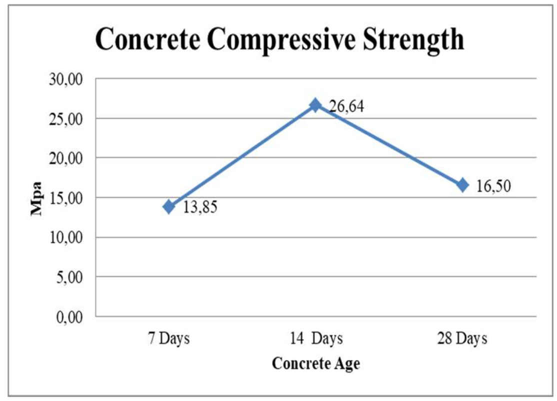


Figure 17. Graph of concrete testing
Source: Research (2023)

Testing the compressive strength of concrete with a design quality of 30 MPa on concrete, aged 7 days obtained an average compressive strength value of 13.85 MPa, and at 14 days of age, obtained an average compressive strength value of 26.64 MPa, and on concrete aged 28 days get an average compressive strength value of 16.50 MPa.

It can be seen in Figure 17 that the causes of the decrease in the quality of concrete are: 1) the use of coarse aggregate used is stone which is broken manually for the 3 samples which are not taken at the same place, then from the process of making concrete samples which are carried out simultaneously or not in one mix for various variations in the age of the concrete. 2) The type of coarse aggregate is not homogeneous. 3) The coarse aggregate used is a type of limestone or lime, so more use of limestone can make the concrete porous or corrosive.

IV. Conclusion

Based on the results and discussion obtained in this study, it can be concluded that:

1. Suryanata Quarry, which has material reserves of ± 539,098 M3, has a distance of 3.7 km from Muhammadiyah University

East Kalimantan and has an average rock strength of 60.78 MPa and 28-day concrete strength of 16.50 MPa. Based on these results, concrete using aggregate from the Suryanata quarry is not recommended for Structural concrete work. Cermin Quarry, which has material reserves of ± 132,060 M^3 the distance from Muhammadiyah University, East Kalimantan is 8.9 Km with an average rock strength of 49, 18 MPa, and Besaung Quarry which has material reserves of ±112,128 M3 with a distance of 10 Km from Muhammadiyah University, East Kalimantan and has a rock strength of 32.48 MPa.

2. The results of abrasion testing from 3 quarry locations in Samarinda City have fulfilled the requirements as concrete coarse aggregate according to SNI 2417-2008.
3. The maximum compressive strength value for rock testing was obtained from the Suryanata quarry at 60.78 MPa, the second maximum rock compressive strength value from the Cermin quarry was 49.18 MPa, and the third maximum rock compressive strength value from the Besaung quarry was 32.48 MPa.
4. The compressive strength of concrete using Suryanata stone obtained a maximum yield of 16.50 MPa. So concrete using coarse aggregate from the Suryanata Quarry is not recommended as structural concrete. But the stone from the local Samarinda quarries can be recommended as foundation work.

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