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Local Wisdom of Builders on The Quality of Making Concrete in Kendari City Southeast Sulawesi Province

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Abstract

In Kendari City, the concrete structure made by construction workers consists of: (a) concrete for the lower class; (b) concrete for middle society, and; (c) concrete for the upper community. The concrete is made with different sand material. This research is important to find out the method of making concrete made by construction workers in Kendari City. This research is intended to test the compressive strength and absorbency of the concrete made by construction workers in Kendari City. This study uses an experimental method with a quantitative approach. Based on laboratory test results that concrete material from 100% Unaha sand with the composition of 1 sack of cement: 4 barrel of unaha sand included in structural concrete. Concrete material from split stone and Pohara sand with a composition of 1 sack of cement: 4 barrel of Pohara sand : 4 barrel of split stone, concrete material from Unaha sand and Pohara sand with a composition of 1 sack of cement: 4 barrels of Unaha sand : 4 barrels of Pohara sand, concrete material from 100% Nambo sand with the composition of 1 sack of cement: 4 barrels of Nambo sand, concrete material from Nambo sand and Unaha sand with a composition of 1 sack of cement: 3 barrels of Nambo sand : 1 barrel of Unaha sand, and concrete material from Nambo sand and Sabulakoa sand with composition of 1 sack of cement : 3 barrels of Nambo sand : 1 barrel of Sabulakoa sand are included in non-structural concrete.

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1. INTRODUCTION

In Kendari City, the spearhead of public housing development is construction workers. The construction workers in making concrete structures are fairly unique. In Kendari City, the spearhead of public housing development is construction workers. The construction workers in making concrete structures are fairly unique. Construction workers in making concrete by self-taught. In architecture, construction workers fall into the category of vernacular architects. Vernacular architecture has been growing over time with continuities, changes, transformations and adaptations to the different social and economic conditions of each period in response to actual needs with the available means of every place. Continuities in vernacular architecture are closely related to space, time and materiality and involve structural, typological, functional and social issues with multiple readings and interpretation (Philokypro, 2015). The vernacular architecture of a region derived out of various factors, such as social, culture, etc. gives more importance to local specific factors such as climate and topography (Dilia, et al., 2010). Vernacular architecture, also referred to as traditional, anonymous, native or indigenous to a specific time and place, is the architecture of people. It is related to the environmental context and available resources, it is customarily owner or community built, utilizing traditional technologies and local materials. All forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of life of the cultures that produce them (Oliver, 2005 & Philokypro, 2015). The strength of vernacular architecture is that it makes buildings that are in natural harmony, built form and people (Dilia, et al., 2010).

Vernacular architecture is a product of an evolutionary process of self correction which is often associated with but not confined to mud houses and thatch roofs, indeed far from the suggested 'primitive form of design, lacking intelligent thought', that it was once perceived as. Vernacular buildings are born out of local building materials, technology and a reflection of the customs and lifestyles of a community (Rapoport, 1969). Vernacular architecture develops and follows the times. Vernacular architecture is architecture without an architect (Rapoport, 1969; Turan, 1990; & Zubaidi, 2009). Vernacular architecture is oriented to locality. Vernacular architecture explores the character of the environment and according to the needs of residents. Based on this, vernacular architecture needs to be developed. This is intended to create a residential context with the environment. Therefore, Indonesian vernacular architecture should be appointed as a source of new architecture. New architecture in today's architectural design. Vernacular architecture can be a tool for developing traditional architecture. Vernacular architecture is houses belonging to people born of the people. Vernacular architecture grows along with tradition. Vernacular architecture conveys the notion of community concepts, identity, and unique (Jeraman, 2008; Hidayatun, 2008; & Abdul, 2010).

Vernacular architecture can be seen as a process and product. Vernacular architecture as a process, as follows: (a) vernacular architecture does not have a designer (architect) clearly. Vernacular architecture is architecture without an architect; (b) vernacular architecture is not designed with the intention to assert themselves; (c) vernacular architecture believes in one single building model and limited variations in building shapes; (d) vernacular architecture are responsive to the environment and users of buildings; (e) vernacular architecture has different nature and size of buildings (does not have certain standards); (f) vernacular architecture according to the needs of residents; (g) vernacular architecture in the design process tends to be congruent, as well as; (h) vernacular architecture changes very slowly and temporarily. Vernacular architecture is seen as a product, as follows: (a) vernacular architecture has a classification of buildings in accordance with local culture; (b) very specific floor plans, shapes and transitions; (c) vernacular architecture has a good relationship between rules and architectural elements; (d) vernacular architecture responsive to the local environment; (e) vernacular architecture has a complexity on a large scale in determining something specific; (f) vernacular architecture varies over time; (g) vernacular architecture accepts and is open to change; and; (h) vernacular architecture are using certain material and quality (Rapoport, 1969; Turan, 1990; & Zubaidi, 2009).

Vernacular architects were built by the community and vernacular architecture used by local communities. Vernacular architecture was designed by construction workers and based on experience (Sahroni, 2012). Vernacular architecture in Indonesia has undergone design acculturation. Transformation of architectural forms tends not to occur, except the use of building materials. Building materials use the latest and most modern products (Erdiono, 2010). Vernacular architecture has distinctive characteristics and uses local materials (Rengkung, 2011). On the other hand, concrete is a very important material. Concrete is widely used to build infrastructure (Manuahe, et al., 2014). Concrete is made economical, easy to form, weather resistant, and high compressive strength. Concrete requires a mixture of proportions, so that the concrete is produced with high compressive strength (Widyawati, 2011). Concrete compressive strength identifies the quality of a structure. The higher the strength of the structure, the higher the quality of concrete (Ahmad, et al., 2009).

The strength of the concrete is influenced by its constituent materials (water, cement and aggregate), so that the quality of the concrete is as desired (Salain, 2007). According to the builder, the composition of the concrete mixture for sloof is 1: 2: 3 (1 cement: 2 sand: 3 gravel). Comparison of concrete mixes can also be used 1: 4 (1 cement: 4 coarse sand) and do not use gravel. Cast concrete is used with a thickness of 2,5 cm. The sequence of concrete mixes used for Sloof consists of two methods. The first method is used in the order of 3 gravel buckets, 1 bucket of cement and 2 buckets of sand. The best concrete mixture if there are more gravel than cement and sand. 2/3 and 2/4 are the best sizes of gravel for concrete mixes. Gravel is feared to be less mixed with cement and sand when the sand is stirred first. This method is also applied when making a house with a large number of floors. The second method is used in the order of cement, sand and gravel. If the gravel and sand are stirred first, it is feared that the cement soluble process will be long (Umar, 2016). According to the educated architect, the concrete mixture for sloof (bottom beam) is sorted from sand, cement and gravel. Sand and cement are mixed first so the dough can easily stick with gravel. The aggregate is stirred manually and mechanically. The aggregate is stirred manually can be sorted by sand, gravel, cement and water. Water is mixed together. The aggregate is stirred mechanically (molen machine). In the first stage, cement and water are mixed together. In the second stage, sand and gravel are added to the molen machine with the planned dose [Umar & Arsyad, 2016).

The composition of the concrete mixture in public housing financed by the bank is 1: 4 or 1: 5. The sand material used is Pohara sand material and Nambo sand material. In general, the sand material used as a mixture of concrete is as follows: (1) Pohara sand material. The characteristics of this sand are gray, coarse and dense textures. Pohara sand material is sold at a price of Rp. 550,000 (five hundred fifty thousand rupiahs) per ret; and (2) Nambo sand material. The characteristics of this sand are white (if dry), red (if excavated), gravel and contain a lot of soil. Nambo sand material is sold at Rp. 350,000 (three hundred fifty thousand rupiahs) per ret. Sloof concrete mixture is made with a composition of 3 sand material lorries from Pohara area, 1 sand material truck from the Nambo area, 1 cement and water sacks. Concrete ringbalk mixture is made with a composition of 1: 3, 1: 4 and 1: 5. The column concrete mixture is made with a composition of 1: 4. Cast concrete sloof, columns and ringbalk made with 2 cm thick. The carport floor rebate mixture is made with a composition of 1: 4. Sand material is used from Nambo sand material, Pohara sand and one cement sack. Floor rebates made with 8 cm thick (Umar, et al., 2017).

Class I concrete is concrete for nonstructural work. Class I concrete implementation does not require special expertise. Quality control is only limited to light supervision of the quality of materials. Compression strength is not required for inspection. Class I concrete quality is expressed as Bo. Class II concrete is concrete for structural work. Implementation requires expertise and must be carried out under the leadership of experts. Class II concrete consists of standard quality: Bl, K125, K175, and K225. In quality B1, quality control is only limited to the supervision and quality of materials. Compression strength is not required for inspection. Quality control of K125, K175, K225 consists of strict supervision of material quality. Quality control requires continuous inspection of concrete compressive strength. Class III concrete is a concrete structural work. Class III quality concrete is used for concrete quality and high compressive strength. Compressive strength higher than 225 kg/cm^2. The implementation of class III quality concrete requires special expertise and must be carried out under the leadership of experts. Class III quality implementation is required in concrete laboratories and complete equipment. Class III quality implementation is served by experts and can carry out continuous quality control of concrete. Class III concrete quality is expressed by the letter K. The numbers behind it state the strength of the characteristics of the concrete (Ahmad, et al., 2009).

The compressive strength of concrete is determined by the arrangement of the ratio of cement, coarse and fine aggregates, water and various types of mixtures. Comparison of water to cement is the main factor in determining the strength of concrete. The lower the water-cement ratio, the higher the compressive strength. The amount of water needed to provide chemical action in the hardening of the concrete. Excess water increases workability but decreases strength (Suseno, etc., 2008). Concrete quality is illustrated by the compressive strength of concrete, because the compressive strength of the rising concrete is followed by the improvement of other concrete properties. The magnitude of the load is broad unity and is produced by a compressive testing machine which causes the crushed concrete test specimen when loaded with a certain force called concrete compressive strength according to SNI 03-1974-1990. Testing of concrete compressive strength is carried out by giving a gradual axial compressive force to the cylindrical specimen, until the specimen has collapsed. The compressive strength of concrete is calculated by dividing the maximum load when the specimen is destroyed with a cross-sectional area of the test object. The compressive strength of the concrete can be searched using the equation (Suarnita, 2011) as follows …………………………………………………………...……….... (1)

$$f^1c = \frac{P_{max}}{A_c}$$

Information:

f^1c	:	Concrete compressive strength (kg/cm^2)
P_{max}	:	Maximum load (kg)
A_c	:	Cross-sectional area of the test object (cm^2)

Thus that, the concrete structure made by construction workers consists of: (a) concrete for the lower class of society;(b) concrete for middle society, and; (c) concrete for the upper community. The concrete is made with different sand material. This research is important, as follows: (a) to determine the quality of concrete made by construction workers in Kendari City; (b) to find out the method of making concrete made by construction workers in Kendari City; (c) to synergize the knowledge of construction workers and academics on concrete, so that effective methods of making concrete can be obtained. This research is intended to test the compressive strength and absorbency of the concrete made by construction workers in Kendari City.

2. METHODOLOGY

This study is uses an experimental method with a quantitative approach. The stages of research are carried out, as follows:

Research Material Preparation Phase

The main materials used in this study are as follows: (a) type I portland cement used in this test with the trademark Semen Tonasa. This cement is purchased with a weight of 50 kg per sack; (b) Clean water is used in this test and meets the requirements for concrete mixtures. Water is available at the Laboratory, Department of Architecture, Vocational Education Program, Halu Oleo University, Kendari; (3) the aggregate consists of coarse aggregates and fine aggregates. Sand material from the Pohara area and sand from the Sabulakoa area is used as fine aggregate. Sand material from the Nambo area, sand from the Unaha area, and gravel are used as coarse aggregates. The location of study in Kendari City can be seen in Figure 1.

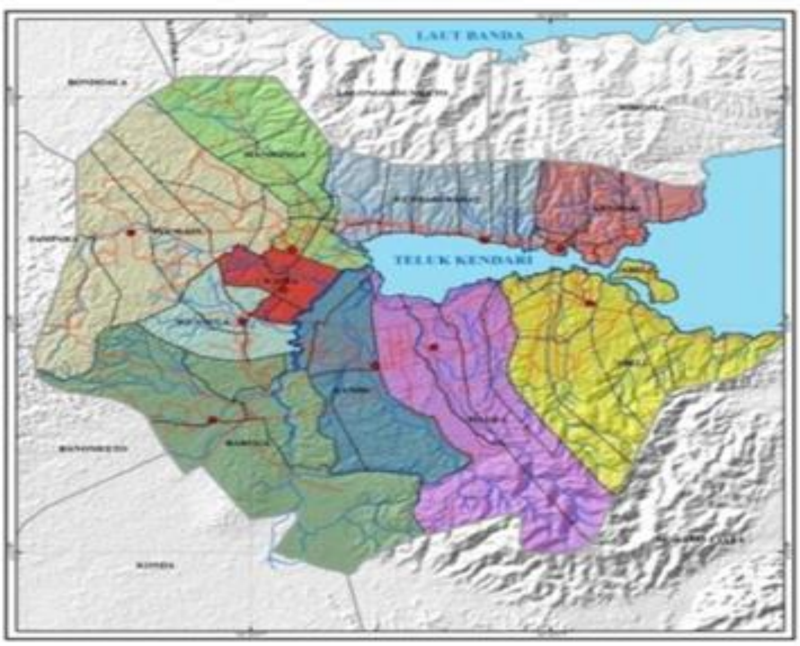


Figure. 1 The location of study in Kendari City
(Source: BPS-Statistics of Kendari Municipality, 2020)

Preparation of Work Tools Phase

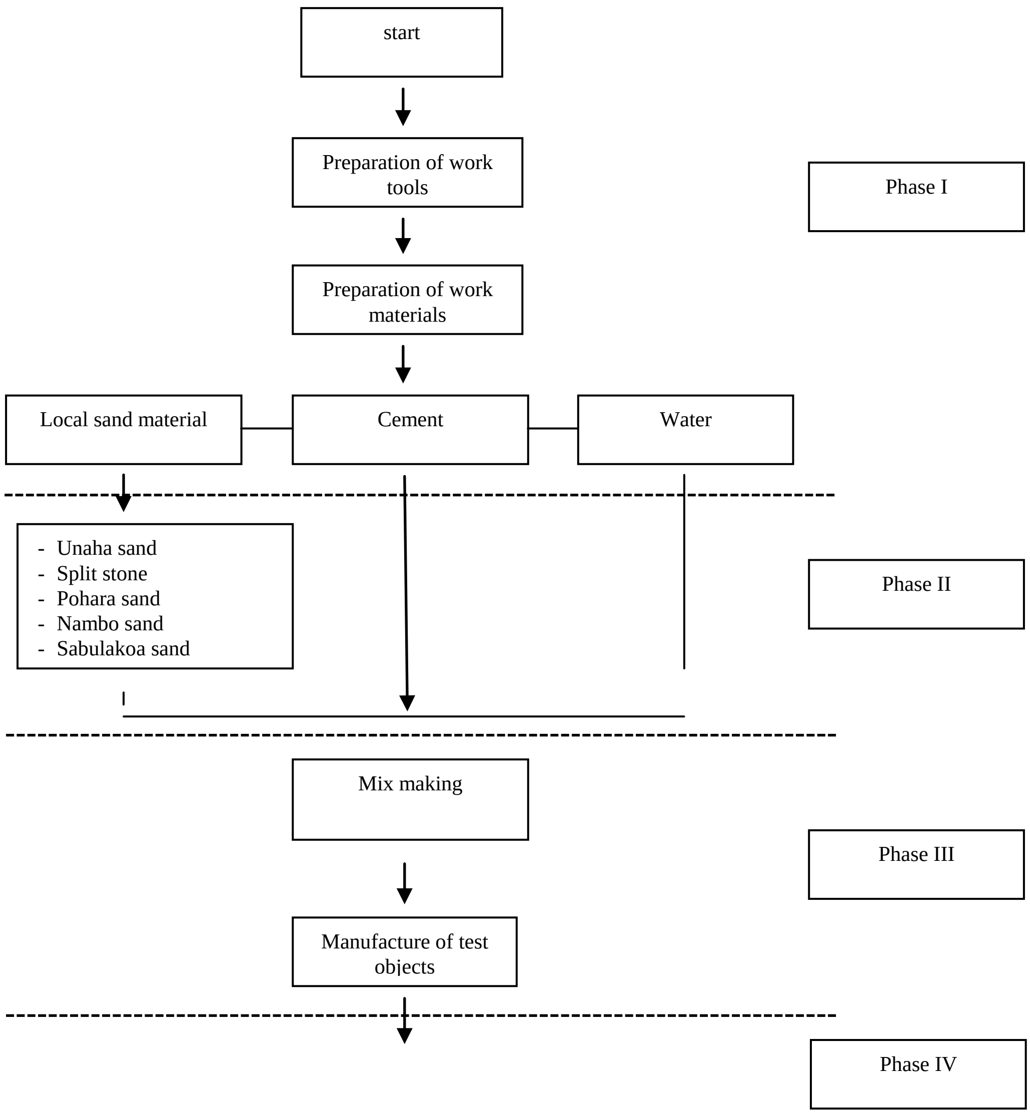
Concrete molds measuring 15 cm x 15 cm x 15 cm, shovels, lorries, buckets, cement spoons, rulers, tools for piercing dough, and palm brooms are used as work tools.

Making Test Objects Phase

The test object is made with three variations and the size of each is 15 cm x 15 cm x 15 cm. Each variation is made into five specimens. Concrete material from Unaahaa sand is made as the first variation. Concrete material from Pohara sand and Nambo sand is made as a second variation. Concrete material from Pohara sand and gravel is made as a third variation.

Testing Phase

The stages of testing are carried out in the following manner: (a) the concrete is dried for one day; (b) concrete is given a code number; (c) concrete is soaked for 28 days; (d) concrete weighed; (e) Concrete is tested with concrete presses; (f) concrete is given maximum load until it collapses; (g) the needle on the press is moved when the object is given a maximum load; (h) maximum load is recorded as Pmax; (i) compressive strength is obtained by the maximum load divided by the area of the specimen. The stages of research can be seen in Figure 2.



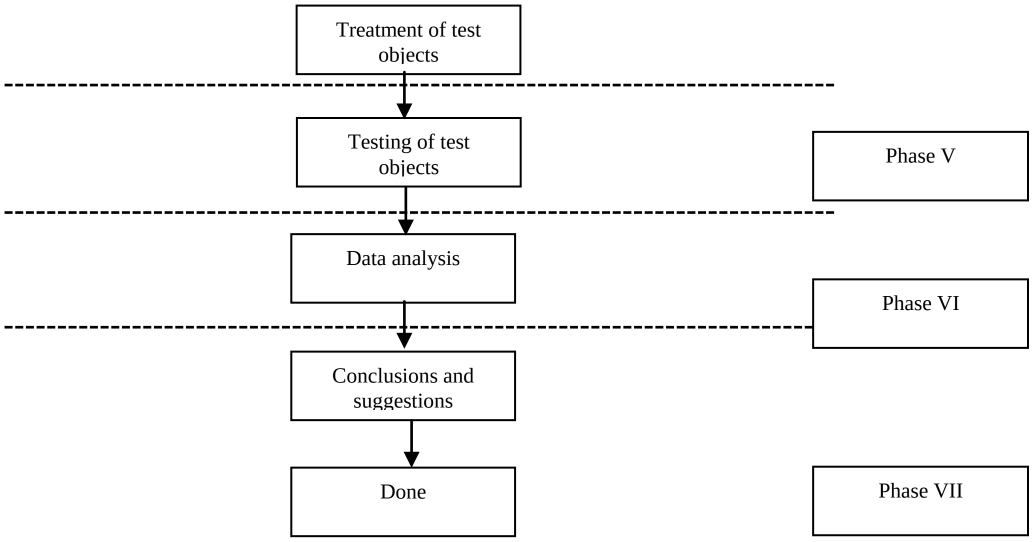


Figure. 2 The location of study in Kendari City
(Source: Umar, 2021)

3. RESULT AND DISCUSSION

Concrete made by construction workers consists of three groups, such as the lower class of society, the middle class and the upper class. Concrete material for the lower classes of society is made with a composition of 1: 4 (1 cement: 4 sand). Three Pohara sand and one Nambo sand are used in this concrete mixture composition. This concrete is often used in public housing financed by the Bank. The color of red sand tends to be bright, the sand contains a lot of soil, gravel sand and the color of white gravel are possessed in the characteristics of Nambo sand (figure 3a). Nambo sand is sold at a price of Rp. 200.000,-/ret up to Rp. 400.000,-/ ret. Concrete material for the middle class is made with a composition of 1: 3 (1 cement: 3 sand). Unaha sand material is used in this concrete. Gray sand color tends to be bright, sand contains a lot of gravel, gray and white gravel colors are owned in the characteristics of Unaha sand (figure 3b). Unaha Sand is sold at a price of Rp. 850.000,-/ret. This concrete is often used in two foors building structures.

Concrete material for the upper class community is made with a composition of 1: 3: 4 (1 cement: 3 sand: 4 split). Pohara sand material is used in this concrete. The color of gray sand tends to be dark, rather coarse and grained sand like sugar / salt is held in the characteristics of Pohara sand (figure 3c). This concrete is often used in building shop houses and office buildings. Pasir Pohara is sold at a price of Rp. 600.000,-/ret. Pohara sand material is often paired with split stones. Split stone is made of mountain rock which is broken manually and mechanically. The split stone is manually solved having varying stone shapes. Split stones that are solved by mechanical means have a uniform shape. This split stone has a size of 2/3 -3/4 cm. In general, the people of Kendari city prefer split stone shapes which are solved mechanically. Split stones are mechanically broken for sale at Rp. 1.500.000,- (one million five hundred thousand rupiahs) up to Rp. 1.700.000,- (one million seven hundred thousand rupiah) per ret (figure 3d). Besides Unaha sand material, Pohara sand and Nambo sand are also Sabulakoa sand. This sand is often mixed with split stones. Sabulakoa sand has characteristics, as follows: (a) solid and smooth like granulated sugar, so it is often used as a wall plaster material; (b) shiny like glass, and; (c) the gray sand material of Sabulakoa tends to be bright. Pasir Sabulakoa is sold at a price of Rp. 850.000,- (eight hundred fifty thousand rupiah) per ret (figure 3e).

Figure. 3 Example of an image with acceptable resolution

Compressive Strenght Test Result

Table 1. The results of the average compressive strength of concrete material from100% unaha sand with the composition of 1 sack of cement: 4 barrels of unaha sand

Sample code	Averages			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm²)**	**Compressive strenght (kg/cm²)**
U1	7281,9	30.000	225	133,4
U2	7291,9	35.000	225	155,6
U3	7100,3	26.000	225	115,6
U4	7635,1	30.000	225	133,4
U5	6977,8	28.000	225	124,5
Compressive strength average				132,5

The results of the analysis of the compressive strength of concrete material from 100% Unaha sand with the composition of 1 sack of cement: 4 barrels of unaha sand, the compressive strength value was 132,5 kg/cm2 (table 1).

Table 2. The compressive strength test results of the average concrete material of split rock and pohara sand with the composition of 1 sack of cement: 4 barrel of pohara sand : 4 barrels of split stone

Sample code	Averages			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm^2)**	**Compressive strenght (kg/cm^2)**
SP + P1	7111,1	14.000	225	62,3
SP + P2	6645,3	13.000	225	57,8
SP + P3	7489,5	12.000	225	53,4
SP + P4	7076,4	11.000	225	48,9
SP + P5	7109,4	10.000	225	44,5
Compressive strength average				53,4

The results of the analysis of the compressive strength of concrete material from split rock and Pohara sand with the composition of 1 sack of cement: 4 barrel of Pohara sand : 4 barrel of split stone obtained a compressive strength average of 53,4 kg/cm2 (table 2).

Table 3. The compressive strength test results of the average concrete material from unaha sand and pohara sand with the composition of 1 sack of cement : 4 barrel of unaha sand : 4 barrel of pohara sand

Sample code	Averages			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm^2)**	**Compressive strenght (kg/cm^2)**
U + P 1	7624,4	24.000	225	106,7
U + P 2	7030,4	20.000	225	88,9
U + P 3	8010,4	11.000	225	48,9
U + P 4	7515,5	14.000	225	62,3
U + P 5	7555,6	19.000	225	84,5
Compressive strength average				78,3

The results of the analysis of the compressive strength of concrete material from Unaha sand and Pohara sand with the composition of 1 sack of cement: 4 barrels of

Unaha sand : 4 barrels of Pohara sand obtained a mean compressive strength of 78,3 kg/cm2 (table 3).

Table 4. The results of the average compressive strength of concrete material from 100% nambo sand with the composition of 1 sack of cement: 4 barrel of nambo sand

Sample code	**Averages**			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm^2)**	**Compressive strenght (kg/cm^2)**
N 1	6770,2	14.000	225	62,3
N 2	7000,3	12.500	225	55,6
N 3	6933,6	14.000	225	62,3
N 4	6704,2	14.500	225	64,5
N 5	6815,3	15.000	225	66,7
	Compressive strength average			62,3

The results of the analysis of the compressive strength of concrete material from 100% Nambo sand with the composition of 1 sack of cement: 4 barrel of Nambo sand obtained a mean compressive strength of 62,3 kg/cm2 (table 4).

Table 5. The results of the average compressive strength of concrete material from nambo sand and unaha sand with the composition of 1 sack of cement: 3 barrel of nambo sand : 1 barrel of unaha sand

Sample code	**Averages**			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm^2)**	**Compressive strenght (kg/cm^2)**
NU 1	6267,2	17.500	225	77,8
NU 2	7183,0	19.000	225	84,5
NU 3	6703,4	15.000	225	66,7
NU 4	8736,3	14.000	225	62,3
NU 5	7289,2	24.500	225	108,9
	Compressive strength average			80

The results of the analysis of the compressive strength of concrete material from Nambo sand and Unaha sand with the composition of 1 sack of cement: 3 barrel of Nambo sand : 1 barrel of Unaha sand obtained a compressive strength of 80 kg/cm^2 (table 5).

Table 6. The results of the average compressive strength of concrete material from nambo sand and sabulakoa sand with a composition of 1 sack of cement: 3 barrel of nambo sand : 1 barrel of sabulakoa sand

Sample code	Averages			
	Weight (kg)	**P_{max} (kg)**	**Broad field (cm^2)**	**Compressive strenght (kg/cm^2)**
N+SA 1	5629,7	9.000	225	40,0
N+SA 2	5862,6	8.000	225	35,6
N+SA 3	6703,5	13.000	225	57,8
N+SA 4	5923,4	8.000	225	35,6
N+SA 5	5691,7	10.000	225	44,5
Compressive strength average				42,7

The results of the analysis of the compressive strength of concrete material from Nambo sand and Sabulakoa sand with the composition of 1 sack of cement: 3 Nambo sandbar: 1 barrel of Sabulakoa sand obtained a mean compressive strength of 42.7 kg/cm2 (table 6).

Comparative Analysis of Compressive Strength Test Result

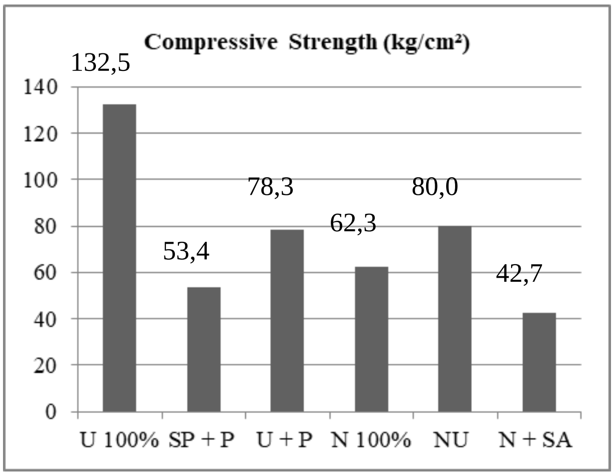


Figure 4 . Compressive strength test results in the form of bar charts.

The compressive strength test results obtained the highest value of concrete material from 100% Unaha sand of 132 kg/cm2. This is presumably due to the characteristics of Unaha sand gravel. These gravels are thought to contain a lot of lime. Lime is known as the main raw material for making cement. Lime is used as a binding and cementing material, so that the Unaha sand material produces high compressive strength. The compressive strength test results obtained the lowest value of 42.7 kg/cm2 of Nambo and Sabulakoa sand material. This is presumably because the characteristics of Nambo sand contain soil and the percentage of Sabulakoa sand that is dense is low (figure 2).

4. CONCLUSIONS

Based on laboratory test results that concrete material from 100% Unaha sand with the composition of 1 sack of cement: 4 unaha sand bins included in structural concrete. Concrete material from split rock and Pohara sand with a composition of 1 sack of cement: 4 sandbar Pohara: 4 split stone barrels, concrete material from Unaha sand and Pohara sand with the composition of 1 sack of cement: 4 barrels of sand Unaha: 4 barrels of sand Pohara, concrete material of 100% Nambo sand with a composition of 1 sack of cement: 4 Nambo sandbar, concrete material from Nambo sand and Unaha sand with the composition of 1 bag of cement: 3 sandbar Nambo: 1 barrel of sand Unaha, and concrete material from Nambo sand and Sabulakoa sand with a composition of 1 sack of cement: 3 Nambo sandbar: 1 Sabulakoa sandbar included in non-structural concrete. The material of Unaha sand and Nambo sand is thought to contain a lot of lime, so the concrete is hard. This research can be continued to examine the lime content of unaha sand material and Nambo sand material.

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