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Performance on soil utilization model as interlock block wall material

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Abstract
Soil characteristics around Kendari City are included in the clay soil category. So far, clay has not been used optimally. Clay is only used as a pile material in buildings. The land around the city of Kendari can be made of brick interlock material. This research is important to be carried out to utilize the surrounding land as building wall material to obtain an economical and effective wall material. This study aimed to test the Land Use model's compressive strength and water absorption performance as an interlock block material in Kendari City. In this study, three treatments were made. Each treatment made 10 test specimens. Test specimens are made with a size of 25 cm x 12.5 cm x 10 cm. The research steps are preparing work tools, preparation of work materials, dry stirring process, moist stirring process, printing, drying, watering, testing, and data analysis. Data collection techniques are carried out in the laboratory. Testing includes compressive strength and water absorption. Based on the results of tests in the laboratory, interlocking brick from the ground has low compressive strength and water absorption. Interlock block can be used as a wall under the following conditions: first, the interlock brick material using clay is the same as the clay used by red brick material; second, interlock brick material from the soil is added with sand material.

Keywords:
Brick interlock;
Compressive strength;
Soil around;
Water absorption.

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INTRODUCTION

The Indonesian state has a wealth of natural resources that are pretty available and tend not to be used optimally [1]. Local material that is reasonably available and tends to be neglected is soil. Soil material is essential for the structure of a building [2]. Soil material is needed for human life [3]. Differences in soil types between regions explain the resilience of the region [4]. The surrounding land can be used as a building material. One of them is building wall material. In the current era, the building wall material is dominated by red stone, brick, and Hebel. People tend to be less aware that there are other alternatives for wall mount materials. In the community, the wall's name is a red stone, brick, and Hebel, and other than the three wall materials, it does not fit well [5]. Soil types in Kendari City are included in the category of cambisol and gleysol [6, 7, 8]. In Indonesia, almost part of the area is dominated by clay [9].

Clay soil has the following characteristics: (1) High plasticity; (2) Stability can be used compaction and additives; (3) Invisible particles; (4) Flat plate-shaped particles; (5) Clay measuring 0.002 mm; (6) Fine-sized clay; (7) The ability to pass particles by penetrating them is low; (8) The rise of liquid through the cracks of soil particles is quite high; (9) Highly sticky; (10) The expansion and depreciation is quite high; (11) The synergy process is slow; (12) High ion exchange capacity; (13) The addition of cement increases the maximum density of the soil; (14) The addition of Metal powder increases the cohesion value of the soil; (15) The addition of lime increases the maximum Dry density of the clay; (16) The addition of fly ash mixture increases the shear strength of the clay; and (17)

The addition of sand reduces the plasticity index of clay [10, 11, 12, 13, 14, 15]. The quality of the wall material can be measured by compressive strength and water absorption. The strength of a material to absorb water is called absorption [16].

On the other hand, housing conditions in Kendari City showed fluctuating conditions during the 2015-2017 period. The percentage of houses with permanent walls increased from 99.18% in 2016 to 99.21% in 2017 [17]. The need for housing is increasing, and the demand for building materials is increasing. The increasing need for building materials needs to be followed by more effective manufacturing. Various manufacturing methods have been carried out in the hope that an efficient method will be found [18, 19]. The development of technological innovation needs to be continuously improved to produce good and economical products [20]. One of them is interlock block wall material. Bricks that have grooves and tongues on the upright sides are called interlock blocks. The vertical sides of the bricks are not given mortar, and the horizontal parts are not given thick mortar. The interlocking block has protrusions and indentations on the top and bottom sides. These protrusions and indentations are used as locks between bricks. The installation of interlock blocks does not require mortar in its installation. The interlocking block has a hole. These holes are used as heat and sound insulation [21].

Compressive strength is synonymous with structural quality. This means that high structural strength must be followed by high quality [22]. Any building materials used should be sustainable. The use of building materials is adjusted to the potential availability of local materials [23]. Interlock block is a sustainable building material because it is energy efficient; effective installation because it saves mortar; interlock block is more stable and sturdy compared to other conventional bricks; flexible interlock block form; functional to the room; low production costs (economic); and minimal use of handyman labor [24, 25, 26].

The disadvantages of interlock blocks are as follows: (1) interlock blocks are less available in the market, so they are rarely used by the public [26]; (2) giving the mixture in the form of grout affects the compressive strength of the interlock block [27]. Nevertheless, interlock block is the right wall material because it is included in the principles of sustainable construction, suitable for mass housing construction, and appropriate for use in houses after natural disasters [28]. The physical characteristics of interlock blocks are as follows: (1) interlock blocks have a good compressive strength of 5.03 N/mm2 and are more economical than hollow concrete bricks made of sand [29]; (3) the quality of the interlock block increases if it is added with additives; (4) the compaction factor affects the quality of the interlock block [30].

In addition, the physical characteristics of other interlock blocks are as follows: (1) the addition of lime can improve the quality of the interlock block, but it is feared that it will break easily; (2) the addition of straw fiber affects the tensile strength and ductility of the interlock block [30]; (3) the strength of the interlock block is increased by smoothing the locking surface of the interlock block [31]; (4) the addition of fiber in the interlock block raw material by 2% to 5% can improve the quality of the interlock block. This increase affects the lateral force and elastic modulus of the wall [32]; (5) the provision of iron reinforcement in each row of interlock blocks increases wall stiffness and reduces lateral forces [33]; (6) interlock blocks should be made by mechanical means. This is intended so that the interlock block has a precise shape. The precision shape affects the strength of the wall. The interlocking block should be grouted so that the wall is stable and sturdy [34]; (7) interlock block can be made from 100% recycled aggregate. Interlock block from recycled materials produces a compressive strength of 32 MPa and has good fire resistance [35]; (8) interlock block at the bottom of the wall should be 25% better than at the top. This is intended to respond to earthquake lateral forces [36].

Interlock blocks can be used as an alternative to installing building walls. Interlock block consists of red brick, brick, and Hebel blocks. Natural colored interlock brick. The process of making interlock bricks is not burned. The stages of making interlock blocks are the printing stage, the compaction stage, and the drying stage. Working materials of interlock block materials from potential soil materials in the surrounding environment and other working materials.

Soil characteristics around Kendari City are classified as clay soil. So far, clay has not been used optimally. Clay is only used as backfill material in buildings. The soil around Kendari City can be made of interlock brick material. It is important to do this research to utilize the surrounding soil as a building wall material in order to obtain an economical and effective wall material. This study was aimed at testing the performance of compressive strength and water absorption in the soil utilization model as an interlock block material in Kendari City.

METHOD

Work Tools

Interlock brick moulding tools, scales, cement spoons, sacks, buckets, shovels, 4 mm sieve, scraper, work floor, oil, brush, palm fiber broom, and hammer are the work tools used in this study.

Portland Cement

In this study, type 1 cement was used. This cement was used for building construction. The weight of cement is 50 kg/bag. This cement is not tested in the laboratory and only follows the manufacturer's specifications.

Land and Water

This research uses clay soil (plinthite podzolic soil). This land was taken from Wuawua Village, Wuawua District, and Kendari City. Red soil conditions tend to be yellowish and moist. Water is taken from Wuawua Village, Wuawua District, and Kendari City borewells.

Additive

The additives used were 8%, 9%, and 10% of the weight of the soil. The samples are presented in Figure 1.

Test Object

In this study, three treatments were made. Each treatment made 10 test objects. The test object was made with a size of 25 x 12.5 x 10 cm. The composition of the working materials on the test object is listed in Table 1.

Research Implementation

This research was conducted in two places. The first place is the manufacture of test objects in Wuawua Village, Wuawua District, and Kendari City. The second place is the place to test the test object.

The test was carried out on Saturday, August 24, 2020, at the Materials and Construction Testing Laboratory, Department of Civil Engineering, Faculty of Engineering, Halu Oleo University. The steps of carrying out the research are preparation of work tools, preparation of work materials, dry stirring process, moist stirring process, printing, drying, watering, testing, and data analysis.

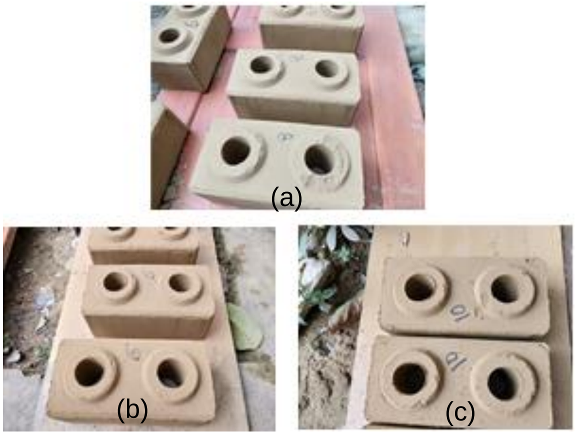

Figure 1. Sample Interlock brick specimens (a) 8%, (b) 9%, and (c) 10%

Interlock Brick Water Absorption Test

Data collection techniques were carried out in the laboratory. Tests include compressive strength and water absorption. The testing of interlock bricks is as (1).

$$f'c = \frac{P_{max}}{A} \quad (1)$$

$f'c$ = Compressive strength (MPa)
P = Maximum load (N)
A = Material cross-sectional area (mm^2)

Data Analysis

Data collection techniques were carried out in the laboratory. Tests include compressive strength and water absorption. The testing of interlock bricks is as (2).

$$Water\ absorption\ (\%) = \frac{B - A}{A}\ X\ 100\% \quad (2)$$

Where:
A = Dry mass of the sample (gr)
B = Wet mass of the sample (gr)

RESULTS AND DISCUSSION

Interlock Brick Compressive Strength

The analysis of the compressive strength of interlock bricks from 50 kg of soil around 5 kg of cement (10%): 7.7 g of additives obtained an average compressive strength of 8.64 kg/cm2.

Table 1. Composition of Working Materials

Code	Surrounding land (kg)	Cement (kg)	Water Cement Factor (gr)	Addition of chemical substances (gr)	Number of samples
8	50	4	2086.9	7.7	5 5
9	50	4.5	2086.9	7.7	5 5
10	50	5	2086.9	7.7	5 5

This value is not included in the compressive strength of Quality IV SNI 3-0349-1989 hollow concrete brick (20 kg/cm2), the compressive strength of SII-0021-78 class 25 red stone, and the compressive strength of NI-10 grade III red stones (80-60 kg/cm2). The data is shown in Table 2.

In Table 3, the analysis of the compressive strength of the interlock brick material from 50 kg of soil around: 4.5 kg cement (9%): and 7.7 g of additives obtained an average compressive strength value of 8.32 kg/cm^2. This value is not included in the compressive strength of Quality IV SNI 3-0349-1989 hollow concrete brick (20 kg/cm^2), the compressive strength of SII-0021-78 class 25 red stone, and the compressive strength of NI-10 grade III red stones (80-60 kg/cm^2).

In Table 4, the analysis of the compressive strength of the interlock brick material from 50 kg of soil around 4 kg of cement (8%): 7.7 g of additives obtained an average compressive strength of 6.08 kg/cm^2. This value is not included in the compressive strength of Quality IV SNI 3-0349-1989 hollow concrete brick (20 kg/cm^2), compressive strength of SII-0021-78 class 25 red stone, and Compressive strength of NI-10 grade III red stones (80-60 kg/cm^2).

Comparative Analysis of Brick Compressive Strength Test Results

Figure 2 explains that the compressive strength test results obtained the highest interlock block material value from 50 kg of soil around 5 kg cement (10%): 7.7 g additives of 8.64 kg/cm2. On the other hand, the compressive strength test results obtained the lowest value of interblock material fromt50 kg of soil around 4 kg cement (8%): 7.7 g additives of 6.08 kg/cm2. The compressive strength of interlock brick material is included in the low category. This is due to the poor strength of the surrounding soil. The surrounding soil is thought to have a high level of clay content, so the target of 20 kg/cm2 has not been achieved.

The target of 20 kg/cm2 may be achieved as follows: (1) The interlock brick material using clay is the same as the clay used by the red brick material; (2) Interlock brick material from the surrounding soil is added with sand material. Therefore, interlock brick material can be used in public housing, provided that the quality of the concrete frame structure is improved.

Table 2. The results of the average compressive strength of interlock brick material from 50 kg of soil around 5 kg cement (10%): 7.7 gr additives

Sample Code	Concrete Weight (gr)	Pmax. (kg)	Area (cm^2)	Strong Press (kg/cm^2)
10%	4.205	3.500	312.5	11.2
10%	4.341	3.000	312.5	9.6
10%	4.192	2.500	312.5	8
10%	3.865	2.500	312.5	8
10%	4.526	2.000	312.5	6.4
Average compressive strength				8.64
Compressive strength of SNI 3-0349-1989 hollow concrete brick (Quality IV)				20
Compressive strength SII-0021-78 grade red stone 25				25
Compressive strength of NI-10 Redstone Level III				80-60

Table 3. The results of the average compressive strength of interlock brick material from 50 kg of soil around: 4.5 kg cement (9%): 7.7 g additives.

Sample Code	Concrete Weight (gr)	Pmax. (kg)	Area (cm^2)	Strong Press (kg/cm^2)
9%	4.392	3.000	312.5	9.6
9%	4.393	2.500	312.5	8
9%	4.211	3.500	312.5	11.2
9%	4.245	2.000	312.5	6.4
9%	4.219	2.000	312.5	6.4
Average compressive strength				8.32
Compressive strength of SNI 3-0349-1989 hollow concrete brick (Quality IV)				20
Compressive strength SII-0021-78 grade red stone 25				25
Compressive strength of NI-10 Redstone Level III				80-60

Table 4. The results of the average compressive strength of interlock brick material from 50 kg of soil around 4 kg cement (8%): 7.7 g additives.

Sample Code	Concrete Weight (gr)	Pmax. (kg)	Area (cm^2)	Strong Press (kg/cm^2)
8%	4.381	1.500	312.5	4.8
8%	3.969	2.000	312.5	6.4
8%	4.035	1.500	312.5	4,8
8%	4.242	2.500	312.5	8
8%	4.088	2.000	312.5	6.4
Average compressive strength				6.,08
Compressive strength of SNI 3-0349-1989 hollow concrete brick (Quality IV)				20
Compressive strength SII-0021-78 grade red stone 25				25
Compressive strength of NI-10 Redstone Level III				80-60

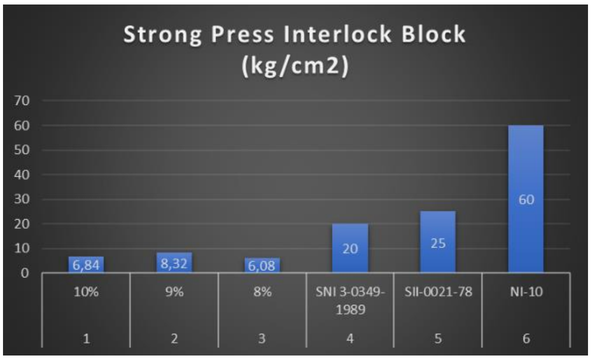

Figure 2. Comparative analysis of interlock brick compressive strength test results

Comparative Analysis of Brick Compressive Strength Test Results

Water absorption results are presented in Table 5. The results of the average water absorption test of interlock brick material from 50 kg of soil are about 5 kg cement (10%):7.7 g additives, the value is 15.576%. Interlock bricks are included in water absorption quality I SNI 3-0349-1989 hollow concrete bricks. The quality I value is below 25%. Interlock brick is included in the red brick water absorption category of less than 20%.

In Table 6, the results of the average water absorption test of interlock brick material from 50 kg of soil are about: 4.5 kg cement (9%): 7.7 g additives obtained a value of 16.565%. Interlock bricks are included in water absorption quality I SNI 3-0349-1989 hollow concrete bricks. The quality I value is below 25%. Interlock brick is included in the red brick water absorption category of less than 20%.

Table 5. The results of the average water absorption test of interlock brick material from 50 kg of soil around 5 kg cement (10%): 7.7 g additives.

Sample Code	Oven Dry Weight (gr) A	Weight of Test Object After Soaking (gr) B	Water Absorption (%) (B – A) / (A) x 100%
10%	4225	4917	16.379
10%	4376	5105	16.659
10%	4159	4847	16.543
10%	4491	5084	13.205
10%	4293	4941	15.095
Average Water Absorption (%)			15.576
Red brick water absorption is less than 20%			20
Water absorption capacity SNI 3-0349-1989 hollow concrete brick (Quality I)			25

Table 6. The results of the average water absorption test of interlock brick material from 50 kg of soil: 4.5 kg of cement (9%): 7.7 g of additives

Sample Code	Oven Dry Weight (gr) A	Weight of Test Object After Soaking (gr) B	Water Absorption (%) (B – A) / (A) x 100%
9%	4402	5128	16.493
9%	4299	5012	16.586
9%	4385	5077	15.781
9%	4392	5105	16.234
9%	4241	4993	17.732
Average Water Absorption (%)			16.565
Red brick water absorption is less than 20%			20
Water absorption capacity SNI 3-0349-1989 hollow concrete brick (Quality I)			25

The results of the average water absorption test of interlock brick material from 50 kg of soil are about 4 kg cement (8%): 7.7 g additives obtained a value of 17.135%. Interlock bricks are included in the category of water absorption quality I SNI 3-0349-1989 hollow concrete bricks. The quality I value is below 25%. Interlock brick is also included in the red brick water absorption category of less than 20%. This explanation is presented in Table 7.

Comparative Analysis of Interlock Brick Water Absorption Test Results

In Figure 3, the results of the average water absorption test of interlock brick material from 50 kg of soil are about 5 kg cement (10%): 7.7 g additives that the lowest value is 15.576%. The results of the average water absorption test of the interlock material from 50 kg of soil are about 5 kg cement (10%): 7.7 g additives, the highest value is 17.135%.

Table 7. The results of the average water absorption test of interlock brick material from 50 kg of soil around 4 kg cement (8%): 7.7 g additives

Sample Code	Oven Dry Weight (gr) A	Weight of Test Object After Soaking (gr) B	Water Absorption (%) (B – A) / (A) x 100%
8%	4087	4933	20.699
8%	4065	4808	18.278
8%	4484	5119	14.162
8%	4270	4984	16.722
8%	4339	5025	15.810
Average Water Absorption (%)			17.135
Red brick water absorption is less than 20%			20
Water absorption capacity SNI 3-0349-1989 hollow concrete brick (Quality I)			25

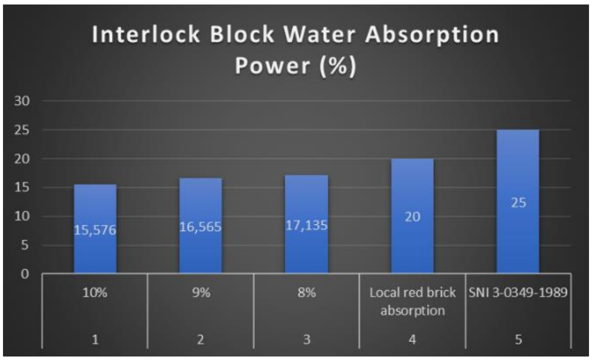

Figure 3. Comparative analysis of the water absorption test results of interlock bricks

Interlock brick has a low water absorption capacity: (1) Additives can break down the material into a denser so that it reduces the number of cavities in the interlocking brick; (2) Additives have unique characteristics when melted. These characteristics are that the additive can solidify itself, and the hardening process is faster. This is what causes interlock bricks to have low water absorption.

CONCLUSION

Based on the results of laboratory tests, interlock bricks from soil have low compressive strength and water absorption performance. Therefore, an interlocking block can be used as a wall under the following conditions: first, the interlock brick material using clay is the same as the clay used by red brick material; second, interlock brick material from the soil is added with sand material.

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