P-ISSN: 2776-7329, E-ISSN: 2776-7310
Proceedings
5th Vocational Education International Conference
Semarang, 13 July 2023

The Effectiveness of using Interlocking Bricks in Housing Walls

Nevy Sandra*, Fajri Yusmar, Irvan Alperi

Teknik Sipil Universitas Negeri Padang
**Corresponding author. Email: nevysandra@ft.unp.ac.id*

ABSTRACT
Nowadays, wall-building material is dominated by clay brick, which requires combustion. Therefore, interlocking brick must be introduced as wall installation material in house construction that is easy to install, strong, without combustion, and environmentally friendly. Several interlocking bricks have been developed and implemented in building constructions. This study aims to determine the effectiveness and characteristics of using interlock bricks as wall materials in house construction in terms of cost, time, and work methods. The properties of interlocking brick were investigated, including the compressive strength, measurement of the volume of the holes, and water absorption. At the same time, data analysis was carried out to determine the effectiveness of using interlock bricks by comparing the cost of work, work methods, and work time of interlock brick walls with conventional bricks. The test results found that the average compressive strength of the interlock bricks was 24.34 kg/cm2, the hole volume was 131.55 cm3, and the absorption of water content was 0.246%. Based on the analysis of calculations for manufacturing type 42 house walls with an area of 112.04 m2. It was found that interlocking bricks are more economical than conventional bricks. Interlock brick takes 168.3 working hours in the same area, while conventional brick takes 638.38 hours. The reduced working time happens because the interlocking bricks use fewer wall installation items than the clay brick. Also, the interlocking brick does not require plastering as with conventional bricks when installation.

Keywords: *Bricks, Wall, Interlock brick, Material, Housing Wall.*

1. INTRODUCTION

Bricks are a building element intended for construction and are made from the soil with or without a mixture of other materials, burned high enough not to be destroyed when immersed in water.[1] These bricks are often used in Indonesia as non-structural materials, such as dividing walls in buildings. Some people also use bricks in simple house construction to support or bear the weight of it.

As one of the materials used for wall construction, brick also continues to experience development. Several types of bricks can be used as an option in making wall construction. These types of bricks are lightweight, adobe, and interlock.

Many studies have been carried out on more environmentally friendly walls, easy to work on and more efficient in working time. At this time, there have been many discoveries about interlock bricks. Interlock bricks are a constituent of walls with hooks to lock movement between bricks, and interlock bricks are a development of adobe brick material by adding lips on certain sides as a lock.

The advantage of interlock bricks is that they do not require particular installation as a binder. Interlock bricks already have hooks or lips that lock one another. In interlock brickwork, there is no need to use sloofs and columns because the bricks themselves have been replaced and also have an attractive appearance, so there is no need for plastering and plastering. Interlock brick has many differences from conventional brick in terms of characteristics, installation, and cost. Therefore, it is necessary to study the effectiveness of interlock bricks in building walls.

2. LITERATURE REVIEW

2.1. Brick

Brick is a building element intended for building construction and is made from soil with or without a mixture of other materials. It is burned high enough so

that it cannot be destroyed again when immersed in water [1].

2.2. Brick Wall Composing Material

2.2.1. Clay

Clay is the primary material for making burnt and sun-dried bricks. The processed clay comes from weathering rocks such as basalt, andesite, granite, and others containing many felsfar. Felsfar is a compound of silica, calcium, aluminum, sodium-aluminum silicates, calcium-calcium aluminium silicates [2].

2.2.2. Water

The water referred to here is an auxiliary material in building construction. It includes its use for manufacturing and maintaining building components, extinguishing lime, making mortar and plaster, and so on. The water must be clean, with a pH between 6 – 8. Then it does not contain visually visible mud, oil, and other floating materials. Water should not have more than 2 g/lt of suspended matter. Water also should not contain salt, such as Cl max. 500 ppm and SO4 max. 1,000 ppm. The compressive strength of the mortar from the sample water is at least 90% of the compressive strength of the mortar using distilled water.

2.2.2. Cement

Portland cement is a hydraulic cement produced by grinding Portland cement slag, especially consisting of hydrolyzed and milled calcium silicate together with additional ingredients in the form of one or more crystalline forms of calcium sulfate compounds, and other additives may be added.

2.2.2. Fine Agregat

Sand, as the main ingredient or aggregate in the manufacture of building components, can be natural sand due to the natural disintegration of rocks or artificial sand produced by breaking stones and having a maximum grain size of 5 mm.

2.3. Brick

Red brick is one of the building elements in building construction made from clay plus water with or without other mixed materials through several stages of processing, such as digging, processing, printing, drying, burning at high temperatures until it matures and changes color, and will harden like a stone after cooling until it cannot be destroyed again when immersed in water [3]

Red brick is an artificial stone made of a material made by humans so that it has stone-like properties. Those properties can only be achieved by heating, burning, or chemical operations [4]

Bricks as building materials must meet the requirements according to SII-0021-78, PUBI-1982, and NI-10-1978, as follows, the color on the cross-section of the cleavage (fault) is uniform and is expressed in dark red, yellowish pink, reddish and so on. Then the shape of the sides must be flat. The edges are sharp and angled, and the surface is flat and not cracked. As well as the standard sizes of bricks according to SII-0021-78 and SK SNI S-04-1989-F can be seen in Table 1.

Table 1. Brick standard size

Modul	Brick size (mm)		Length
	Thick	Width	
M-5a	65	90	190
M-5b	65	140	190
M-6	55	110	230

In addition, the salt content in bricks cannot exceed 50%. Meanwhile, the absorption of good bricks is 20%, and the bulk density of bricks is 2.8 kg/dm. Then the compressive strength of the bricks according to SII-0021-78 and SKSNI S-04-1989-f is explained in Table 2 below.

Table 2. Brick quality based on the compressive strength

Grade	The average compressive strength of 30 bricks tested in the laboratory (kg/cm^3)	Allowable coefficient of variation of conditions (%)
25	25	25
50	50	50
100	100	100
150	150	150
200	200	200
250	250	250

3. RESEARCH METHOD

This study was carried out in the construction of houses using interlock brick walls as a dividing wall. This study evaluates the effectiveness of using interlock bricks in terms of cost and time to make walls. Also, the study determines the characteristics of compressive strength, water absorption, and volume area of interlock bricks. The research carried out is an assessment of the characteristics of interlock bricks, such as compressive strength, hole measurement, and water absorption.

The data needed in this study are cost data, the price of one unit of interlock bricks and red bricks, the cost of installing 1 square meter of brick wall, and the cost of supporting materials.

4. RESULTS AND DISCUSSION

4.1. Compressive Strength

The results of the interlock brick compressive strength test were obtained as shown in table 3 below with the average compressive strength is 24,34 kg/cm^2.

Table 3. Interlock brick compressive strength results

No	Area (cm^2)	Weight (kg)	Load (kg)	Compressive strength (kg/cm^2)
1	200	2693,45	5380	26,91
2	200	2761,66	3850	19,23
3	200	2800,01	5380	26,89

4.2. Water Absorption

Table 4. Interlock brick water absorption

Sample	Saturated water (gr)	Oven dry (gr)	Water Absorption (%)
Brick 1	2755,5	2203,8	0.25
Brick 2	2676,2	2140,8	0.25
Brick 3	2670,0	2145,4	0.24

Table 4 shows the interlock brick water absorption. Water absorption that occurs in interlock bricks is 0.246%.

4.3. Interlock Brick Hole Volume

The average hole volume for interlock bricks is 131,55 cm^3 as shown in Table 5. The hole volume of the interlocking brick fulfills the SNI for perforated concrete bricks with a hole volume of only 14% of the cross-sectional area, whereas the SNI allows no more than 25% of the cross-sectional area of the brick.

Table 5. Interlock brick hole volume

Sample	Test			Average
	1	2	3	
Brick 1 Hole 1	131,18	129,56	130,53	130,53
Brick 1 Hole 2	129,84	134,11	130,53	131,5
Brick 2 Hole 1	132,88	135,03	134,35	134,1
Brick 2 Hole 2	132,20	135,43	133,2	133,61
Brick 3 Hole 1	134,61	125,86	127,33	129,26
Brick 3 Hole 2	128,34	128,84	133,75	130,31

4.4. Interlock Brick Effectiveness

Table 6. Brick unit price

Material	Unit Price	Amount	Price/m^2
Interlock Brick	Rp 2.000	65	Rp 130.000
Brick	Rp 800	70	Rp 56.000

Brick unit prices of conventional and interlock bricks are shown in Table 6. The unit price of interlock bricks is Rp. 2000, so the cost of installing 1 m^2 of a wall that requires 65 pieces of interlock bricks is Rp. 130,000. While the price of 1 conventional brick is IDR 800, and the cost of installing 1 m^2 of walls using 70 conventional bricks is 56,000. The price of interlock bricklaying is higher than conventional bricklaying.

4.5. Discussion

From the compressive strength test results, it was found that the interlock bricks were at IV brick quality with a compressive strength of 24.34 kg/cm2. For water absorption testing, interlock bricks absorb less water than red bricks. Meanwhile, for the volume of holes, interlock bricks have a hole volume of 14%, which means it is still smaller than the permissible hole volume requirement of 25%.

Interlock brickwork does not require plastering because the bricks are left exposed and give a classic impression. Finishing work uses varnish to provide a shiny appearance and close pores to make it waterproof.

Table 7. Comparison of material prices

No	Materials	Unit	Unit Price	Brick		Interlock Brick	
				Quantity	Price/m²	Quantity	Price/m²
1	Cement	kg	Rp 1,260	20.99	Rp 26,447	0.45	Rp 567
2	Sand	m³	Rp 110,000	0.067	Rp 7,370	0.085	Rp 9,350
3	Finishing paint	kg	Rp 26,720	0.26	Rp 6,947	-	Rp -
4	Varnish	Ltr	Rp 32,400	-	Rp -	0.2	Rp 6,480
5	Base paint	kg	Rp 30,000	0.1	Rp 3,000	-	Rp -
6	Reinforcement	kg	Rp 11,935	-	Rp -	1.58	Rp 18,857
7	Worker	OH	Rp 75,000	0.72	Rp 54,000	0.125	Rp 9,375
8	Foreman	OH	Rp 120,000	0.0413	Rp 4,956	0.0313	Rp 3,756

No	Materials	Unit	Unit Price	Brick		Interlock Brick	
				Quantity	Price/m²	Quantity	Price/m²
9	Bricklayer	OH	Rp 100,000	0.35	Rp 35,000	0.0938	Rp 9,380
10	Painter	OH	Rp 100,000	0.063	Rp 6,300	0.063	Rp 6,300
Total					Rp 144,021		Rp 64,065

Table 7 shows the comparison of material prices of brick and interlock brick. The materials used to manufacture walls using conventional bricks are cement, sand, cover painting, and base paint, while cement, sand, varnish, and steel reinforcement are used for the interlock bricks.

Laying of interlock bricks in wall construction is different from conventional bricks. This difference is like the finishing work of the walls. Several work items, such as plastering, wall finishing of cement paste, and paint finishing, have been needed for conventional bricks. Meanwhile, on interlock brick walls, finishing work is enough with varnish as a polisher to produce a more excellent shape. From these differences, the costs for making walls are quite different regarding material use and installation costs.

Table 8. Wall construction time

No.	Work item	Interlock Brick	Brick
1	Brick laying	2 hours 24 minutes	1 hour
2	Plastering	-	1 hours 36 minutes
3	Wall finishing for pasta cement	-	1 hours 12 minutes
4	Varnish	30 minutes	30 minutes

It takes 5 hours and 42 minutes to work on 1 m^2 of brick for bricklaying, plastering, plastering, and painting, while interlock brickwork which includes brickwork and finishing with varnish, takes 1 hour and 30 minutes as shown in Table 8.

Completing all the walls of a type 42 house using red bricks takes 638 hours and 38 minutes. Meanwhile, the interlock brick takes 168 hours and 3 minutes.

Table 9. Price comparison per square meter of conventional bricks with interlock bricks

Work item	Brick	Interlock Brick
Brick Price	Rp 56.000	Rp 130.000
Work Cost	Rp 144.021	Rp 64.065
Total	Rp 200.021	Rp 194.065

The cost of using interlock bricks is 2.91% cheaper than conventional bricks. The total cost of installing conventional bricks per square meter is Rp. 200,021 and interlock bricks are Rp. 194,065 as shown in Table 9.

4. CONCLUSION

From the results of the interlock brick test, it can be seen that the brick is in quality IV for compressive strength with a test result of 24.34 kg/cm2, while for water absorption, the interlock brick absorbs less water than perforated concrete brick with the quality I, the hole volume of the interlock brick meets SNI for perforated concrete bricks with a hole volume of only 14% of the cross-sectional area wherein SNI is allowed no more than 25% of the cross-sectional area of the brick. The use of interlock bricks for wall installation in a type 42 house with a wall area of 112.04 m2 saves Rp. 667,232 of conventional brick. Interlock brick work is more concise because there is no mortar and plaster work with a total of 27 days of conventional brick work, while interlock brick work time is 7 days. In this way, the processing time for interlock bricks is almost four times faster than conventional bricks.

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