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Analysis of Brick Compressive Strength and Water Absorption Based on Various Furnace Duration

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Abstract. This research aims to describe: (1) compressive strength of M-5a module brick 7 days, 9 days, and 11 days furnace time, (2) water absorption M-5a module brick 7 days, 9 days, and 11 days, and (3) compressive strength difference of M-5a module brick 7 days, 9 days, and 11 days. The methods are: (1) making raw brick which is composed by a portion of rice husk and 3 portions of clay to 120 bricks, (2) dehydrating on sunlight for 7 days, then going furnace for 7 days, 9 days, and 11 daysusingrice husk, (3) examining to obtain data ofcompressive strength andwater absorption each 20 bricksofbrick 7 days, 9 days, and 11 days furnace time, and (4) analyzing descriptive statisticandone-way variant analysis. The result obtain that: (1) average ofcompressive strength of M-5a module brick 7 days furnaceis35,80 kg/cm2, 9 days furnaceis 37,30 kg/cm2, 11 days furnaceis 39,30 kg/cm2. Examined compressive strength of brick is not suitable to SNI No: 15-2094-2000, (2) average of water absorption of M-5a module brick 7 days furnaceis22,96 %, 9 days furnaceis21,50 %, and11 days furnaceis19,25 %.Maximum water absorption of brick is suitable to SNI No: 15-2094-2000 on 11 days furnace, and (3) No significant difference on brick compressive strength average amongs module of M-5a on 7 days, 9 days, and 11 days furnace time.

Keywords: Compressive strength, water absorption, furnace.

INTRODUCTION

Brick utilization in building purpose needs standardized quality of brick by Indonesia National Standard (*Standar Nasional Indonesia*)no. 15-2094-2000.All this time, people using brick form local craftsmen in SidenrengRappang regency do not knowthe quality of brick.

The problems in this research are: (1) how is compressive strength of M-5a module brick 7 days, 9 days, and 11 days furnace time?, (2) how is water absorption M-5a module brick 7 days, 9 days, and 11 days?, and (3) how iscompressive strength difference of M-5a module brick 7 days, 9 days, and 11 days?

Brick is building element which is used in construction, made from soil with or without addition, burned in high temperature so it cannot be broken just by soaking

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into water. Next, Iramanti and Sunaryo (1987), state that raw material used in brick and roof tile is clay. Clay is one of natural composition in soil layer.

From explanation above, it is concluded that brick composition is clay with or without other addition.

Purbokusumoand Widodo (1997), state that in case material preparation to make brick, dig clay is mixed with water, stepped, and added sand if needed to ease making process. Mixture is neither dry nor fluid enough so that plastid and before casting, mixture is deposited less than 12 hours (a night) in order to raw soil scrubcan be wrecked itself, then the mixture gets better.

Ceramic Research Center of Bandung (1982), explains that clay stirred bare hand into raw brick then is printed wood cast and the wood should be hard and dry. Inner size is determined by calculating mass depletion total, as brick dimension fits the standard. In order to inner part is not worn out, and its dimension is not changed,it is better to set iron or zinc thin surface.

Purbokusumoand Widodo (1997), casting is conducted using wood crock. Cast making have to calculate total soil depletion, maximum 10% dried depletion and 2% burned depletion, in case raw brick have desired or standard sizes after being burned. Cast filling is conducting by throwing dough to the cast and slicing extra dough using wire cutter. By pressing cast, raw brick will go out itself.

Addleson, L (1971), expresses that printed brick shall be dried on indirect sunlight place because water will go out as sunlight effect so brick will crack. Heinz Frick and Ch. Koesmartadi (2006), drying process takes ± 2-7 days long.

Field stove according to Purbokusumo (1997), is unfixed stove, yaitu which is stacked from raw brick itself. Arrangement in such away creates small cleft for hot airway from furnace. On lower pile of inner brick stack is 4 or 5 rows, there is a long pit width about 40 cm, and fuelled by wood.

According to Kuswaraand Dudung (1979), generally to determine furnace's end is observing upper layer of burned brick. Next, Heinz Frick and Ch. Koesmartadi (2006), state that furnace at ± 800^0(fairly difficult to be reached by rice husk)for 4-5 daysmakes raw brick bears on water and weather. Edwar Allen (2005), states thatbricks in stove area near fire will maximum burned; the furthest brick will be pliable. In the end, this brickare chilled in controlled condition to gain color and avoid thermal crack.

Brick color depends on chemical composition of clay and temperature also fire chemical in fireplace. Higher temperature results in darker brick color. Angus J. Macdonald (2002) states that other brick installment features are durable and able to set into inner and outer building areas. This material exists on whole area, so it does not need long distance transportation.

Industrial Standard of Indonesia(*Standar Industri Indonesia*)no. 0021-1978, declares thatcompressive pressure of test object is resulted asquotient weightiest burden and smallest pressure area. Loading speed is equally setto 2 kg/cm^2/sec.

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Average compressive strength is number of pressure of object test per object test amount.

Brick's water-absorption percentage is absorbed water percentage of oven dry test object until brick become saturated. Brick will be saturated if it is soaked in water.

Indonesia National Standard No: 15-2094-2000, presuppose solid brick for wall installment, occupying visible characteristic, size and tolerant, compressive strength, hazardous salt, pseudo-density, and water absorption. Especially size and tolerate, compressive strength, and water absorption are:

Size. Standard brick size as module, describe in Table 1 below:

Table1. Brick Size

Module	Size (mm)		
	Density	Width	Length
M-5a	65±2	90±3	190±4
M-5b	65±2	100±3	190±4
M-6a	52±3	110±4	230±4
M-6b	55±3	110±6	230±5
M-6c	70±3	110±6	230±5
M-6d	80±3	110±6	230±5

Compressive Strength

Allowed minimum compressive strength and variant coefficientof brick based on the class are described in table 2 below:

Table2. Compressive Strength Number

Class	Minimum compressive strength 30 tested		Allowed variant coefficient
	Kg/cm^2	N/mm^2	(%)
50	50	5	22
100	100	10	15
150	150	15	15

Water Absorption

Maximum water absorption for wall installment brick is 20 %.

RESEARCH METHODS

This type of research is descriptive research. The manufacture of test objects is carried out in the local handicraft industry in SidenrengRappang Regency. Whereas testing compressive strength and moisture absorption of bricks made in the

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The number of bricks tested in this research are a total of 120 pieces of bricks, for the purpose of testing the compressive strength and moisture absorption. The test object must be stored in a place that is not exposed to water after the combustion process is complete in accordance with the predetermined furnace time, namely 7 days, 9 days, and 11 days. The variables and research design are shown in table 3, as follows:

Tabel 3. Variables and research design

Variables	Furnace time (day)and jumlah test object (total)		
	7	9	11
Compressive Strength	20	20	20
Water Absorption	20	20	20
Number	40	40	40
Total		120	

The data analysis technique used is descriptive analysis, which is to calculate the average value of the test results for the test object for compressive strength and water absorption. Furthermore, to determine the difference in the compressive strength of the three combustion periods, one variant analysis was carried out. The data that had been analyzed were then consulted with the Indonesian National Standard No: 15-2094-2000.

RESULT AND DISCUSSION

Result

The description of the results of the test for the compressive strength of Module M-5a bricks, furnace time of 7 days, 9 days, and 11 days, is presented in table 4. as follows:

Table 4. Average of compressive Strength Testin Results

Object	Compressive Strength (MPa)	Compressive Strength(Kg/cm2)
7-days group	3,58	35,80
9-days group	3,73	37,30
11-days group	3,93	39,30

Table 4 shows that the three groups of test specimens of bricks: those 7 days have an average compressive strength of 35.80 kg / cm ^{2} ,a group of 9 days have an

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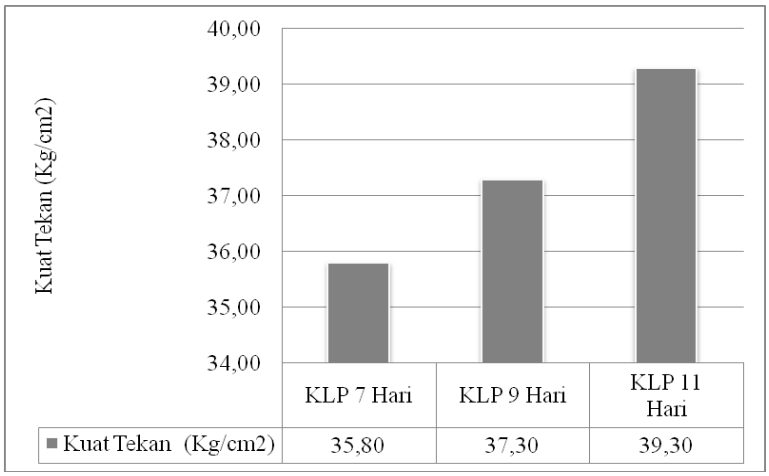
average compressive strength of 37.30 kg / cm ^{2}, a group of 11 days have the average compressive strength of 39.30 kg / cm ^{2}. The average compressive strength test results brick three groups specimen is 37.47 kg / cm ^{2}. The graph of the average test results for the compressive strength of bricks for the three groups of brick specimens is shown in Figure 1, as follows:



Graph1. Average of compressive Strength Testing Results Graph

The graph of the average compressive strength test results of bricks shows that there is an increase in the average compressive strength of bricks from a 7-day furnace time of 35.80 kg / cm2 to 37.30 kg / cm2 at 9 days of burning. Furthermore, there was an increase in the average value of the compressive strength of the bricks during the 11 days of furnace to 39.30 kg / cm2 which was the highest average value of the compressive strength of the bricks of the three groups of brick furnace time studied. The value of the increase in the average compressive strength of a brick from the 7 days to the 9 daysfurnace time is 1.50 kg / cm2; the increase in the average compressive strength of bricks from the 9-day to the 11-day furnace time was 2.00 kg / cm2. Furthermore, the increase in the average compressive strength of bricks from the 7 days to the 11 daysfurnace time is 3.50 kg / cm2.

Description of the water absorption test results for Module M-5a bricks furnace time of 7 days, 9 days, and 11 days.

Table 5. Average Water Absorption Test Results

Test Object	Wet Weight A (gram)	Weight after oven B (gram)	Water Absorption (%)
7-days group	1914,95	1556,95	22,96
9-days group	1922,45	1582,35	21,50
11-days group	1912,00	1618,40	19,25

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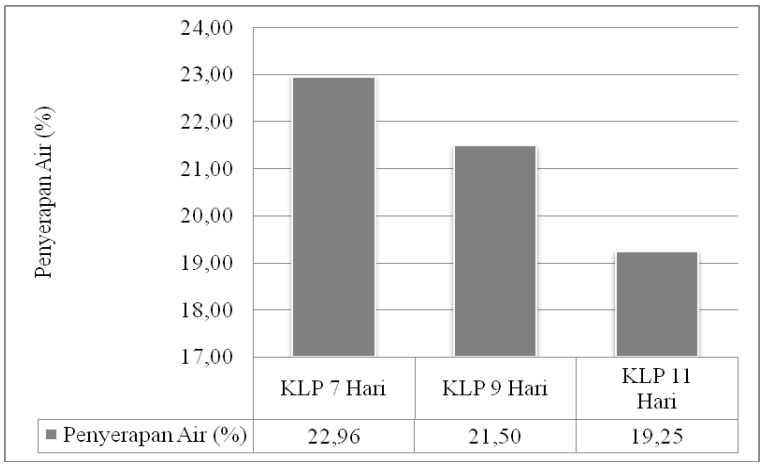
Table 5 shows that the three groups of brick specimens, namely: the 7-day group had an average water absorption of 22.96%, the 9-day group had an average water absorption of 21.50%, the 11-day group had an average water absorption of 19, 25%.

The graph of the average water absorption test results of the bricks test results for the three groups of brick specimens is shown in Figure 2, as follows:



Graph2. Average Water Absorption Test Results Graph

The graph of the average water absorption test results for bricks shows that there is a decrease in the average water absorption value of bricks from the 7-day furnace time of 22.96% to 21.50% in the 9-day furnace time. Furthermore, there was a decrease in the average value of brick water absorption during the 11-day furnace period to 19.25%, which was the decrease in the average value of the lowest brick water absorption of the three groups of brick furnace time studied.

The amount of decrease in the average value of water absorption of bricks from the 7 days to the 9 daysfurnace time is 1.46%; the decrease in the average value of water absorption for bricks from the 9-day furnace time to the 11-day furnace time was 2.25%. Furthermore, the decrease in the average value of water absorption for bricks from the 7 days to the 11 daysfurnace time was 3.71%.

Description of the difference in the compressive strength of Module M-5a bricks, furnace time of 7 days, 9 days, and 11 days.

The results of testing the compressive strength of bricks from the three groups of bricks furnace time to see the difference, after being processed using the SPSS version 21 for Windows program, are presented in table 6 as follows:

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Table 6. Anovaresult for compressive strength of the 7 day group9 days, and 11 days

ANOVA					
Kuat Tekan Batu Bata					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	122.967	2	61.484	2.063	.136
Within Groups	1698.649	57	29.801		
Total	1821.616	59			

Ho: All three groups have the same average value of compressive strength.
H_1: The three groups have different average compressive strength values.
Criteria:
Receive Ho, if Sig.> α = 0,05
Reject Ho, if Sig. < α = 0,05

Because the Sig = 0.136> α = 0.05, Ho is accepted or the compressive strength of the bricks for the three groups of test objects is the same. Conclusion: There is no significant difference in the compressive strength of the M-5a module bricks at the furnace time of 7 days, 9 days, and 11 days.

Discussion

The research results discussed were the results of testing the compressive strength of Module M-5a bricks, furnace time of 7 days, 9 days, and 11 days, the results of the water absorption test for Module M-5a bricks, furnace time of 7 days, 9 days, and 11 days, and differences in the compressive strength of Module M-5a bricks with a furnace duration of 7 days, 9 days, and 11 days.

Based on the research results in table 4 and depicted in graphical form in Figure 1, it is shown that the average value of the compressive strength of the bricks increases with the addition of brick furnace time. It can be understood that the process of furnace bricks to obtain a higher compressive strength is greatly influenced by the duration of brick burning.

The duration of furnace bricks is less than 7 days, will result in a lower compressive strength, conversely, if it is burned for a longer period of time, it will cause the brick to experience a decrease in strength due to the clay being crushed, broken, and the brick surface is curved.

The average value of the compressive strength of bricks as shown in table 4, is still below SNI No: 15-2094-2000, which has not reached class 50 which is the lowest classification of compressive strength of bricks. The low compressive strength of bricks is caused by the way of molding the bricks which is not solid and the time spent furnace the bricks in the furnace which still requires additional furnace time; the process of furnace bricks using fuel in the form of rice husks.

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Based on the research results in table 5 and depicted in graphical form in Figure 2, it shows that the average water absorption value of the bricks has decreased with the addition of brick furnace time. It can be understood that the process of furnace bricks to obtain a lower moisture content is greatly influenced by the duration of brick burning.

The duration of furnace bricks is less than 7 days, will result in a higher average water absorption value, on the other hand, if it is burned for a longer period of time or more than 7 days, it will cause the brick to experience a decrease in its water absorption value. This can happen because the bricks are burned longer, causing the clay to ripen and harden so that when submerged in water, the bricks do not easily get into the clay grains; different when the clay is still wet and the furnace is not yet cooked.

The average value of water absorption for bricks as shown in table 5 , for 7 days and 9 days of furnace time still exceeds the maximum water absorption requirements in SNI No: 15-2094-2000 , which is 20%. Except for the 11-day furnace period it has met the requirements for a maximum water absorption of 20%.

The use of bricks in the wall installation of a building if it has a moisture content of less than 20%, does not require soaking it before installing the bricks. Based on Table 6, the results of the analysis of differences in the compressive strength of bricks in the 7 days, 9 days, and 11 days furnace time group, using one-way Anova, show that there is no significant difference in the average value of the compressive strength of bricks in the 7 day furnace time. , 9 days, and 11 days. Even though Figure 4.2 shows a nominal difference in the average compressive strength values of the 7 days, 9 days, and 11 days furnace time group. There was no significant difference in the average value of the compressive strength of the bricks, due to the short furnace time interval of 2 days for each group of specimens, so that the combustion process to reach the ripped level for each group of bricks in the furnace was not optimal.

CONCLUSION

1. The average value of compressive strength brick module with the old M-5a burning 7 day amounted to 35.80 kg / cm^2, long burning 9 days obtained was 37.30 kg / cm^2 , and at long furnace 11 days was obtained for 39, 30 kg / cm2. The compressive strength of the bricks studied did not meet SNI No: 15-2094-2000.
2. The average value of water absorption brick module with the old M-5a furnace 7 day amounted to 22.96%, on a long burning 9 days gained amount to 21.50% ,and the long burning 11 days obtained by 19.25%. The maximum water absorption of the bricks studied has met SNI No: 15-2094-2000 at 11 days of burning time.
3. There was no significant difference in the average compressive strength of the M-5 a module bricks at 7 days, 9 days, and 11 days of burning time.

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REFERENCES

Addleson, L. 1991. *Material for Building*. Volume 3. An Architect and Building News Book. London.

Angus J Macdonald. 2002. *Struktur dan Arsitektur*. Jakarta : Erlangga.

Badan Standarisasi Nasional. SNI No. 15-2094-2000. *Bata Merah Pejal untuk Pasangan Dinding*.

Edward Allen. 2005. *Dasar-dasar Konstruksi Bangunan*. Jakarta : Erlangga.

Heinz Frick, Ch. Koesmartdi. 2006. *Ilmu Bahan Bangunan*. Yogyakarta: Kanisius.

Iramanti dan Sunaryo. 1987. *Kuat tekan dan peyerapan air Tanah Liat Sebagai Bahan Baku Bahan Bangunan*. Semarang : Balai Penelitian dan Pengembangan Industri.

Kuswara dan Dudung. 1979. *Pembuatan Batu bata dan Genteng*. Bandung : Direktorat Penyelidikan Masalah Bangunan.

Purbokusumo dan Widodo. 1997. *Pedoman Teknik Perencanaan dan Pembangunan Perumahan Pedesaan*. Jakarta : Direktorat Jenderal Cipta Karya, Direktorat Perumahan

Trihendradi. 2013. Langkah Mudah Menguasai SPSS 21. Yogyakarta: Penerbit Andi.