Thermal Conductivity of Compressed Stabilized Earth Brick (CSEB) Different Rate Percentage of Binder Use

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Abstract. The level of conductivity of building skin material is one of the factors that influence the thermal conditions of a space, compressed stabilized earth bricks are proven to be more economical, environmentally friendly, stronger and have better ability to withstand the rate of heat propagation compared to ordinary firebrick , the number of percentages of the use of binder (binder) on bricks without burning will affect the level of thermal conductivity, in this article we test bricks without fires with the level of the number of percentages of use of different binder materials, bricks without fires with a smaller percentage of binder material / a little will have a slower rate of heat conductivity (better) and the higher the percentage of the use of binder material, the level of heat conductivity will be faster (not Good).

Keywords: conductivity, thermal, brick without burning, Binder

1. Introduction

Thermal comfort is a comfort condition that is felt by humans as a result of the hot-cold conditions of a room / environment. Building leather has an important role to create the thermal comfort of a space. The decrease / increase in temperature in the room is influenced by conduction, convection, and radiation factors. The heat transfer through a wall depends on the conductivity of the material in the building. Heat storage capacity in bricks (0.26Wh / kg K) and soft wood (0.14Wh / kg K). According to (SNI 2001) comfortable temperature is <27.1oC and> 20.5oC with humidity of 40% -60% and according to (MENKES 2002) the comfortable temperature for office buildings is 18 oC-28oC with humidity of 40% -60%

For the people of Indonesia, bricks are the first choice of building materials to be used as a house wall. Bricks are building materials made from clay with or without a mixture of other materials, which are burned at high temperatures. So that it makes the material solid and not easily destroyed. Combustion is usually done by arranging bricks in such a way that there is room for dry rice husk as a combustion medium. Burning bricks is done for approximately 4-5 days, by continuing to use rice husk until it becomes coals. The process of combustion in large quantities, produces large carbon dioxide gas as well. This carbon dioxide gas is the cause of environmental problems.

Brick without burning or compressed stabilized earth brick (CSEB) is one of the bricks making technology by adding material that makes the soil stable and compacting, the added material is binding or binder. According to A.Y.B Anifowose (2002), one of the main functions of the binder or binder is to reduce the nature of the expanding soil through changes in the rigid structure of the soil mass, as well as increasing strength and durability.

Cement is the stabilizer most widely used for soil stabilizers. Research by P.J Walker and T. Stace (1997) shows that soils with a plastic index below 15 are suitable for stabilizing with cement. Usually the cement binder is added between 4% to 10% of the dry weight of the soil. If the cement content is more than 10%, it is not economical to produce CSEB bricks. For bricks that use cement less than 5%, often too loose or easily broken (P.J. Walker, 1995)

Research conducted by Ruzaimah (2010), the thermal conductivity test shows that compressed earth brick (CEB) has a lower value than ordinary bricks. These initial findings illustrate that CEB has the potential to improve indoor comfort so that it can act as an alternative building material that is more environmentally friendly.

Research conducted by D.E. Purnama (2016) about the thermal comfort of buildings with bamboo and red brick material in Mojokerto. The results of the field measurements are measured at the time the activity takes place (08.00-16.00 WIB) air temperature and the best average decrease is in the office workspace. The results of the best measurements compared to other materials (wood) with the results of a wall thickness of 5cm (brick = 8.41oC, wood = 7.07oC) and thickness of 24cm (brick = 5.58oC, wood = 4.5oC), so it can be concluded a decrease the best temperature on wood material with a thickness of 5cm.

From the above background, we will test the thermal conductivity of bricks without burning or compressed stabilized earth blocks (CSEB) with different percentages of binder (cement): MD I: 30%, MD II: 20%, MD III: 10%).

2. Methods

In order to know the level of thermal conductivity in bricks without combustion is done through the measurement of the rate of thermal propagation in 3 (three) types of samples, each using a binder percentage: MD I: 30%, MD II: 20%, MD III: 10%. which is done by heating on one side of each test object for 180 minutes and recording the heat changes on the outside and inside of each test object at intervals of every 10 minutes, from the measurement results then we do a comparison and analysis so that it can known Thermal Conductivity of Brick without Burn at Various Percentage Rates of Binder Use, To avoid refraction of the measurement results, ordinary brick is used as a reference (control variable)

3. Results and Discussion

3.1. Type Weight and Pressure

From the results of the measurement of the specific gravity of unburned bricks, design mix 1 has a greater weight compared to design mix 2 and 3. The greater the density of unburned bricks is directly proportional to the compressive strength. Brick without fuel mix design 1 composition of 70% clay and 30% cement. Whereas for design 2 mix is 80% clay and 20% cement, and for design mix 3 the composition is 90% clay and 10% cement. From the composition of the design mix, it is clear that the proportion of 30% cement stabilizer produces a large compressive strength. So the strength of a brick without burning is very dependent on the amount of stabilizer or cement.

Campuran	Benda Uji	Dimensi			Luas Permukaan (mm2)	Beban (N)	Kuat Tekan (MPa)	Rata-Rata Kuat Tekan (MPa)
		P (mm)	L (mm)	T (mm)				
Mix Desain 1	MD1-1	110	110	40	12,100	130,000	10.74	10.74
	MD1-2	110	110	45	12,100	135,000	11.16	
	MD1-3	110	110	45	12,100	125,000	10.33	
Mix Desain 2	MD2-1	115	105	40	12,075	80,000	6.63	6.69
	MD2-2	115	110	40	12,650	85,000	6.72	
	MD2-3	115	110	40	12,650	85,000	6.72	
Mix Desain 3	MD3-1	110	105	40	11,550	55,000	4.76	4.41
	MD3-2	110	105	40	11,550	50,000	4.33	
	MD3-3	110	110	40	12,100	50,000	4.13	

Figure 1. compressive strength measurement data

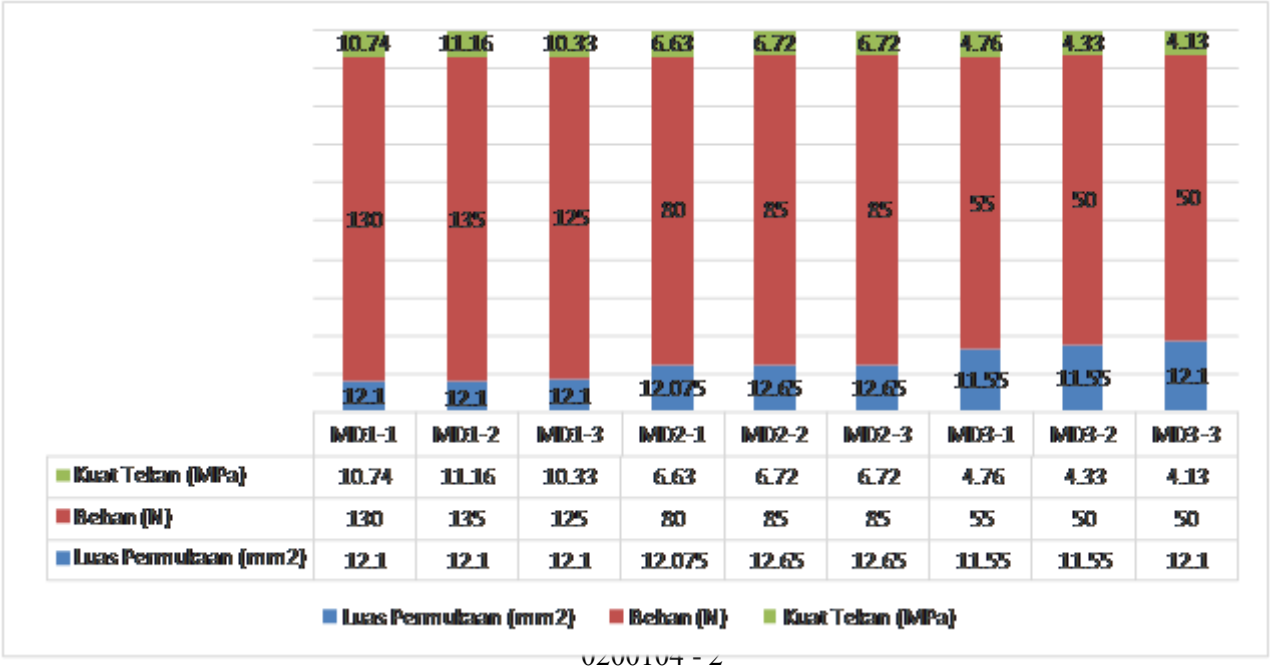

Figure 2. Brick Compressive Strength Test Results Without Burning

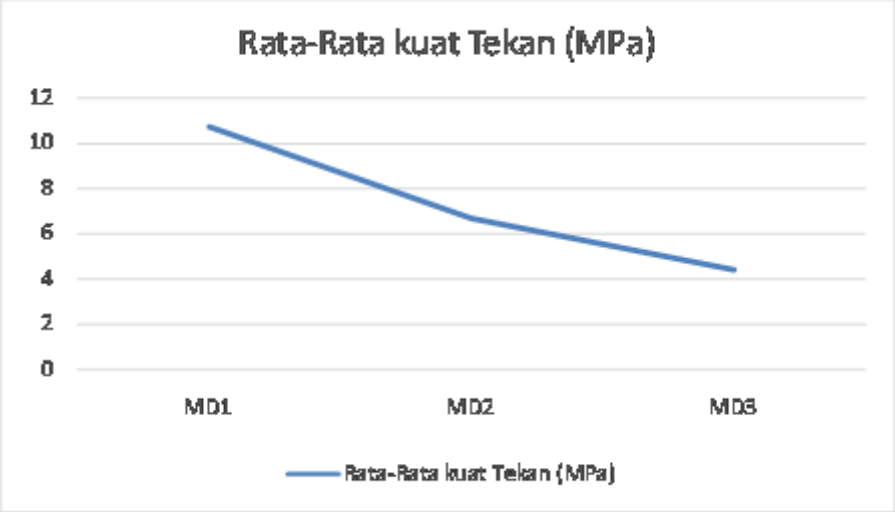

Figure 3. Average Compressive Strength of Brick Without Burn

3.2. Thermal Conductivity

Based on the measurement data of thermal conductivity in table 3 which compares 3 (three) types of Composition Mix of unburned brick material with regular burnt brick which is measured every 10 minutes for 200 minutes where the test brick unit is conditioned in such a way where the heat source comes from (Iron Plate) placed on one side of the 4 test bricks and then measured the temperature of the test bricks on the other side to measure the conductivity level of each test object, then the measurement results can be read as follows:

Time, Minute	Plate Temperature C	Suhu Bata (C)			
		MD1	MD2	MD3	TB
10	31.0	30.6	30.0	30.0	31.2
20	33.6	30.9	31.0	31.0	32.7
30	35.3	34.7	32.9	32.5	33.5
40	36.7	33.4	33.8	32.2	33.7
50	38.2	35.0	36.0	34.5	34.6
60	39.1	35.6	35.6	35.0	35.7
70	38.4	35.9	35.8	35.4	37.6
80	38.0	35.9	36.1	35.6	36.4
90	40.1	37.1	36.9	36.3	36.9
100	40.2	37.4	37.5	36.5	37.0
110	36.0	36.0	36.0	37.0	38.2
120	38.6	37.3	37.4	37.2	37.2
130	40.6	37.8	37.7	37.2	37.8
140	40.9	37.9	37.9	37.6	38.1
150	39.0	37.8	38.1	37.3	37.9
160	42.0	38.6	38.4	38.2	38.5
170	40.4	39.0	39.1	38.6	38.7
180	40.6	38.8	38.8	38.6	38.3

Figure 4. Data on the Measurement of Thermal Conductivity of Brick without Burn

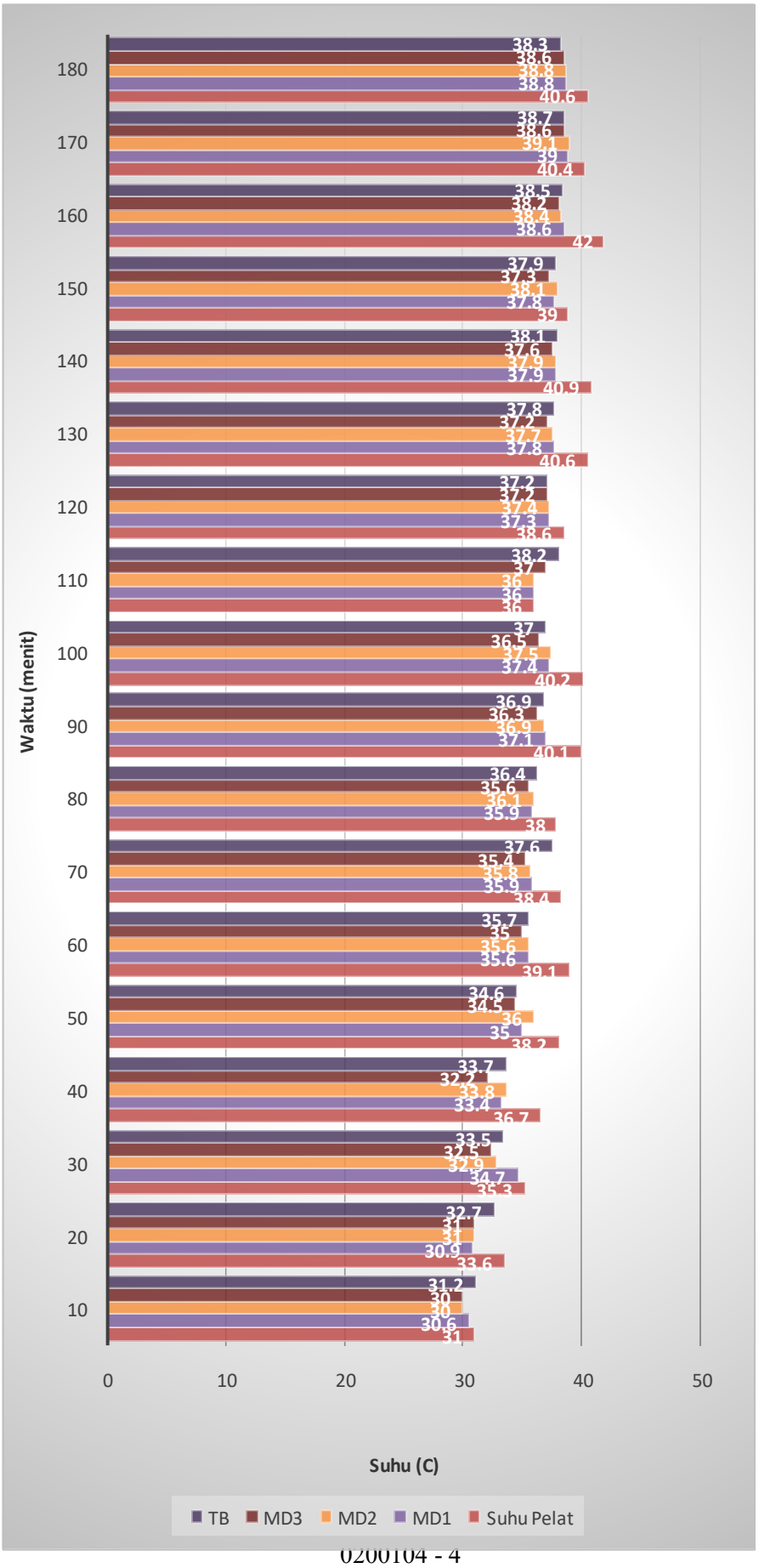
Waktu (menit)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
38.3 38.6 38.8 38.8 40.6
38.7 38.6 39.1 39 40.4
38.5 38.2 38.4 38.6 42
37.9 37.3 38.1 37.8 39
38.1 37.6 37.9 37.9 40.9
37.8 37.2 37.7 37.8 40.6
37.2 37.2 37.4 37.3 38.6
38.2 37 36 36 36
37 36.5 37.5 37.4 40.2
36.9 36.3 36.9 37.1 40.1
36.4 35.6 36.1 35.9 38
37.6 35.4 35.8 35.9 38.4
35.7 35 35.6 35.6 39.1
34.6 34.5 36 35 38.2
33.7 32.2 33.8 33.4 36.7
33.5 32.5 32.9 34.7 35.3
32.7 31 31 30.9 33.6
31.2 30 30 30.6 31
0
10
20
30
40
50
Suhu (C)
TB
MD3
MD2
MD1
Suhu Pelat

Figure 5. Data Pengukuran Konduktifitas Termal Bata Tanpa Bakar

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- At a heating time from 0 minutes to 20 minutes, ordinary brick (TB) has the highest conductivity level, whereas MD1 has a moderate conductivity level, while MD2 & MD3 has a low conductivity level.
- During the 30 minute warm up, MD1 has the highest conductivity level, whereas TB has a moderate conductivity level, while MD2 has the lowest conductivity level and MD3 with the lowest conductivity level.
- During the warm-up minutes from 40 to 50, MD2 has the highest conductivity level, while TB & MD1 has a moderate conductivity level, while MD3 has a low conductivity level.
- During the warm up minutes from 60 to 80, TB has the highest conductivity level, while MD1 & MD2 have a moderate conductivity level, while MD3 has a low conductivity level.
- During the 90 minute warm up, MD1 has the highest conductivity level, while MD2 & TB has a moderate conductivity level, while MD3 has a low conductivity level.
- During the 100 minute warm-up, MD2 has the highest conductivity level, whereas MD2 has a moderate conductivity level, whereas TB has the lowest conductivity level and MD2 with the lowest conductivity.
- During the 110 minute warm-up the TB has the highest conductivity level, while MD3 has a moderate conductivity level, while MD1 & MD2 have a low conductivity level.
- During the 120 minute warm up, MD2 has the highest conductivity level, while MD2 has a moderate conductivity level, whereas TB & MD2 has a low conductivity level.
- In the warm up time of Minute 130, TB & MD1 have the highest conductivity level, whereas MD2 has a moderate conductivity level, while MD3 has a low conductivity level.
- In the warm up time of Minute 140, TB has the highest conductivity level, while MD1 & MD2 have a moderate conductivity level, while MD3 has a low conductivity level.
- During the warm up time of Minute 150, MD2 has the highest conductivity level, whereas TB has a moderate conductivity level, whereas MD2 has the lowest conductivity level & MD3 with the lowest conductivity.
- During the 160 minute warm-up, MD1 has the highest conductivity level, whereas TB has a moderate conductivity level, while MD2 has the lowest conductivity & MD3 with the lowest conductivity.
- During the warm-up minute of 170 minutes, MD2 has the highest conductivity level, while MD1 has a moderate conductivity level, whereas TB has the lowest conductivity level & MD3 with the lowest conductivity.
- During the 180 minute warm up, MD1 & MD2 have the highest conductivity level, while MD3 has a moderate conductivity level, whereas TB has a low conductivity level.

4. Conclusion and Recommendation

Based on reading the comparison data based on the heating time from minute to minute above, the overall results of this measurement can be concluded as follows:

1. In the compressive strength test can be clearly read on the test results, where the percentage of the use of binders is directly proportional to the level of compressive strength on the brick without burning, this means the greater the percentage of binders used, the stronger and harder the brick without burning and the smaller the percentage of the use of the number of binders, the lower the strength and hardness of the brick without burning it.
2. Based on the test results of the thermal conductivity level of the four test objects do not show the same constant and consistent results continuously but based on further reading of the test data it can be seen the tendency of patterns of changes in the level of thermal conductivity that can be used in determining the level of stability the conductivity.
3. 2. MD2 has the highest conductivity level while TB has a moderate conductivity level, whereas MD1 has the lowest conductivity level and MD3 has the lowest and stable conductivity level.
4. 3. MD3 is a better material compared to ordinary firebrick because it has the lowest and most stable thermal conductivity value so that it will be able to optimally withstand the propagation of temperature from outside into the room / building when used as a building shell.
5. Based on conclusions 1, 2, 3 and 4 above, the final conclusion can be drawn that the total percentage of binder use in bricks without burning will produce the opposite quality if viewed from two different aspects, where when viewed from its strength, the greater the percentage of binder use (cement), the brick without burning will be stronger and harder, but when viewed from the level of thermal conductivity, the smaller the percentage of the use of binder (cement), the better the level of thermal conductivity of the unburned brick

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