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The Study of Compressive Strength of Interlocking Brick by Using Bottom Ash Instead of Cement

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ABSTRACT

The study of interlocking bricks that compose of bottom ash replacing a percentage of cement is the study of the properties of interlocking bricks that are produced with the mixture of cement and aggregates in ratio 1:5, 1:6, 1:7, 1:8 and 1:9 by weight of each composition, cinders will be used 0%, 5%, 10% and 15% replacing cement. It is found that the maximum compressive strength is 72.951 ksc with a ratio of 1:6 with 5% of bottom ash; its compressive strength exceeds the standard. It is shown that this composition is the most appropriate mixture for designing bricks. The minimum compressive strength is 55.045 ksc with a ratio of 1:9 with 15% of bottom ash, which consists of a lot of aggregates and bottom ash that have replace of cement, this causes the compressive strength to be lower than the standard. The compressive strength of interlocking bricks which composes of bottom ash between 0% - 5% by weights, the capacity of compressive is optimum. If the bottom ash used in the composition are more than the stated rate, the compression capacity will reduce respectively the amount of bottom ash used which will cause a lower the standard. In case of no bottom ash used, the compressive strength will be a little higher.

Key words: Interlocking brick, bottom ash, cement.

INTRODUCTION

Interlocking brick is the construction materials which is very popular nowadays andemphasized on the use of materials in the area such as clay, laterite, crushed dust and sand mixed with cement and water in the right proportions.Then, compression molding with dry compressed machine moisture cured for at least 7 days and let it coagulated. We will get strongly interlocking bricks and can be used in the bearing wall construction.

Cement is the mainly material in construction industrial. However, we have to destroy natural resources to get the cement such as limestone mountain including the nearly ecosystem. Moreover, it also resulted in several problems of environmental pollution.Thus, if we have the materials which can replace cement, it can reduce the severity of impacts occur.

Bottom ash from the industrial factory is waste from the production process which is one problem that the industry is experiencing about disposal.The main component of bottom ash is alumina and silica. Thus, from its component, it can be used to produce interlocking bricks instead cement. In addition, we adding value to waste but also reduce environmental pollution.

Materials and Methods

This research aim to study about the processing of interlocking bricks by bottom ash from thewaste of industrial animal food production instead of using cement

2.1 Preparation and testing of materials used in interlocking bricks production:

2.1.1 Bottom ash from industrial factory:

Bottom ash comes from the burning process of BTG Feed Mill Co.ltd inChong Sarika sub-district, Patthananikom district, Lobburi province. The sludge is a waste or industrial waste bottom ash from coal as fuel in the production of animal feed. So, the bottom ash that must be disposedis two ton in a day which cannot be utilized and the company has to charge a lot per month to hire a firm to treat the waste to the landfill.

Preparation of bottom ash to be used in this research is dry them in the shade without water or

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any moisture and then, bearing the bottom ash by sieve No.20. These bottom ash will be suitable to produce interlocking bricks, following by figure 1.

Fig. 1: Bottom ash.

2.1.2 Laterite:

Laterite is making of stone decay with time and the actions of different environments. The soil from each country is not the same including grain size, shape, mixed size, and the minerals in soils are different.

2.1.3 Cement:

Portland cement type 1 which is standardized is the material of interlocking bricks production. The cause of using Portland cement type 1valuable compared with the price. It can produce standard interlocking brick which not use too much cement and the brick is strong and corrosion resistance of the water.

2.1.4 Sand:

Sand is granitic that split out of great stone. The sand is separated out naturally. Sand sizes are between 1/12" to 1/400". If these are smaller it becomes dust sand.

2.1.5 Materials properties test:

The making of interlocking brick, we need to test the properties of materials before mixing design process. By specific gravity and absorption of fine aggregate testing in order to find the specific gravity and water absorption of bottom ash, sand, and laterite which use in the testing process.

Fig. 2: Tools for sand and bottom ash testing.

2.2 The design of quantity and composition used in the production of interlocking bricks:

This research was planned to test the interlocking brick which using bottom ash instead of cement. Thetest requires a sample brick size to 12.5 × 10 × 25 cm. By mixing cement with soil at a ratio 1:5, 1:6, 1:7, 1:8 and 1:9 by weight.Each mixture is mixed at bottom ash content of 0%, 5%, 10% and 15% by weight. Extrusion by hydraulic machine. Incubated for 28 days and then tested to find out the compressive strength.

2.3 The production and castings, sample of interlocking brick:

2.3.1 Interlocking brick producing process:

Steps in the production of interlocking bricks will be made under the terms of the compression brick experimental design as well as 100 samples. The specimen is specified conditions. The sequences of steps are

1) Preparation material, winnowing laterite and sand by using 4 mm sieve to separate the contaminants and collect only the laterite and sand.
2) Bring all of the ingredients to measuring by scales.
3) Mix all the ingredients, blend it and then added the water.
4) Compress the sample brick by hydraulic compressing machine into 12.5 × 10 × 25 cm sized.
5) Dry the sample brick indoor only 1 day. Test it with moisture.Arrange and bread enough water to dampen it. Covered with a plastic sheet to keep steam in next 28 days. After that, testing the compressive strength of interlocking bricks based on the standardized interlockingbricks (TIS.57-2530) by setting exposure standards minimum at 70 ksc.

Fig. 3: Interlockingbricks.

Results and Discussion

Before designthe volume and rate of the ingredients used to produce bricks, it necessary to test the quality of all materials to design the materials of sample interlocking bricks. After that, test the compression by mixture ratio cement on laterite. To find out the suitable ratio of the strongly interlocking bricks made of bottom ash from the industrial.

3.1 Bottom ash:

Bottom ash which using as the material of interlocking brick is come from the burning process of BTG Feed Mill Co.ltd in Chong Sarika sub-district, Patthananikom district, Lobburi province. Before use it, we have to test the specific gravity and percent absorption of fine aggregate standards ASTM C 128-97.With a specific gravity table at table 1.

Table 1: Tested for specific gravity and absorption of fine aggregate.

Tested for specific gravity and absorption of fine aggregate	
Gross weight of dry surface saturation (ssd);(g)	500.00
Weight cylinder + Gross weight of dry surface saturation (ssd) + Water weight; (g)	977.00
temperature (c^o)	30.00
Weight cylinder; (g)	140.00
The weight of the cone + Gross weight of drying; (g)	635.00
Gross weight of drying; (g)	495.00
Weight cylinder + Water weight; (g)	666.00
Specific gravity of dried aggregates	2.62
Gross weight of dry surface saturation	2.65
The specific gravity	2.69
absorption percentage	1.01

3.2 The test result of compressive strength and density:

How to test compressive strength of interlocking bricks is following by the standardized test of Thailand Industrial Standard TIS.57-2530. Testing samples were incubated at 28 days of age, five samples per set included 100 samples.

Table 2: The compressive strength and density of interlocking brick in each ratio of the percentageof various bottom ash.

Ratio (Cement: laterite)	Percentage of Bottom ash	Compressive strength (kg/ cm^2)	Density (kg/m^3)
1 : 5	0	72.084	2,182.21
	5	69.341	2,202.83
	10	61.071	2,209.02
	15	56.697	2,116.20
1 : 6	0	77.367	2,221.4
	5	72.951	2,202.83
	10	63.774	2,188.39
	15	59.858	2,147.14
1 : 7	0	67.638	2,216.24
	5	64.232	2,213.15
	10	61.122	2,186.33
	15	59.154	2,185.30
1 : 8	0	65.079	2,245.12
	5	64.151	2,209.02
	10	59.440	2,173.96
	15	58.349	2,190.46
1 : 9	0	64.151	2,209.02
	5	63.468	2,204.90
	10	57.757	2,196.65
	15	55.045	2,197.68

From table 2, The compressive strength and density of interlocking brick in each ratio of the percentage of various bottom ash incubation period in 28 days found that the highest compressive strength was at 77.367 kg/m^3 , the ratio was at 1:6 (Cement : Laterite). Zeropercent of bottom ash which was highest value. It showed that this was the suitable ratio to design the interlocking brick mixed ingredients. The compressive strength at minimumis 55.045 kg/m^3 at ratio 1:9 used 15percent of bottom ash included lot of laterite and the amount of bottom ash is used to replace the stone. The compressive strength values lower than the standard.

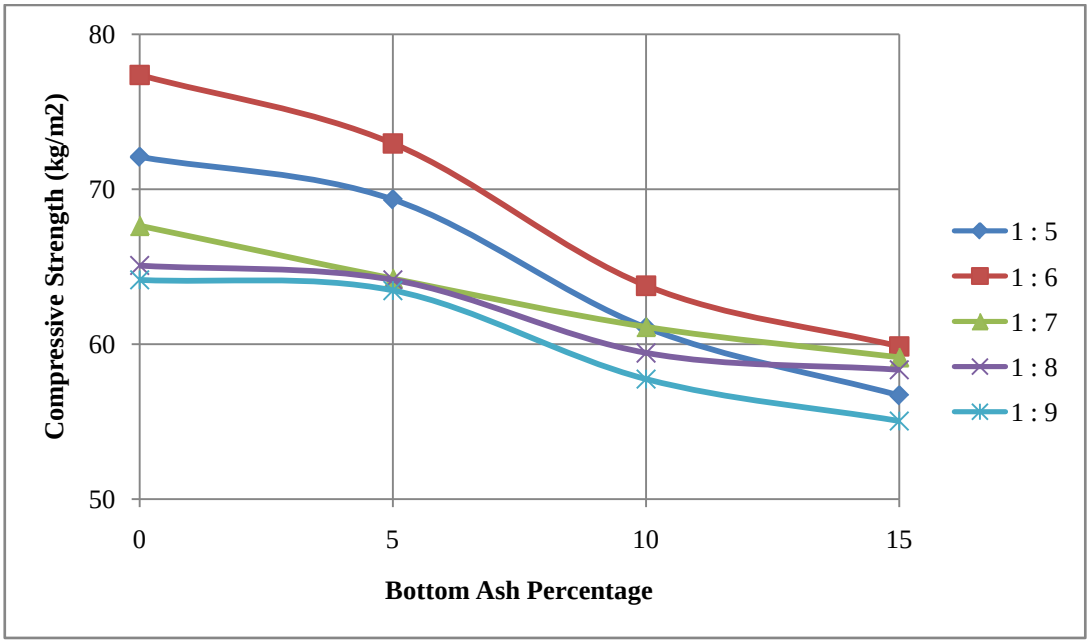

Fig. 4: The relationship between percentage of bottom ash and compressive strength.

From figure 4 shows the relationship between percentage of bottom ash and compressive strength found that the compressive strength of interlocking bricks that mix bottom ash zeropercent to 5 percent by weight will have the ability to get maximum strength. If the bottom ash is too much, the ability of compressive strength will be reduced accordingly.It lowers than standard criterion. If the ratio is not including bottom ash, the compressive strength is slightly higher.

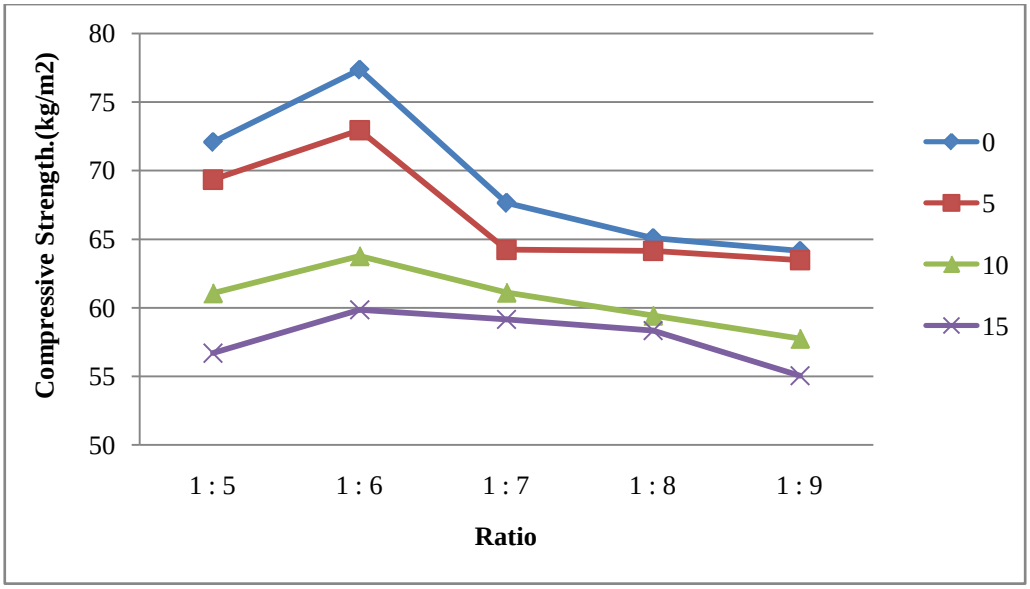

Fig. 5: Shows the relationship between the compressive strength and ratio.

From figure 5 shows the relationship between ratio and the compressive strength found that ratio at 1: 6 (Cement: laterite) has the highest strength in increasing the percentage of bottom ash which clearly shows that these ratio has the ability to get the best compression.

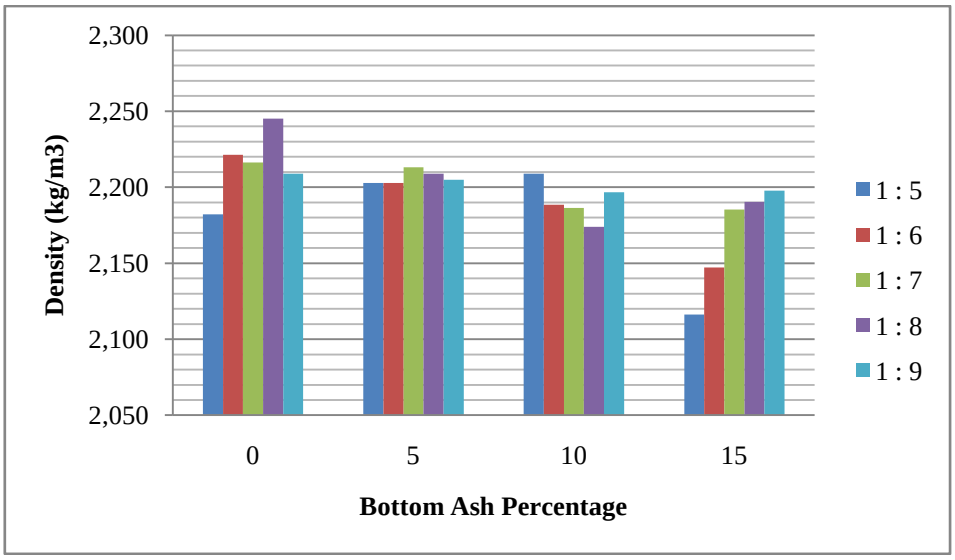

Fig. 6: The relationship between percentage of bottom ash in each ratio and density.

Figure 6 shows the relationship between percentage of bottom ash in each ratio and density of 28 days sample interlocking brick found that the density of the sample is slightly different. It was decreased when adding more bottom ash because the specific gravity of the bottom ash is less than the specific gravity of cement and bottom ash is more flexible. When mixed all the ingredients, the interlocking brick is expansion. It make concrete not stick. Thus, increasing the amount of bottom ash to replace cement and density decreased, but the difference is slightly.

3.3 Testing the water absorption of the interlocking brick:

Testing the water absorption of the interlocking brick is tests to determine the physical properties of the sample moisture content and analyze the sample after the test in the ability to absorb, absorbency and variants of the interlocking brick condition after being affected by moisture.

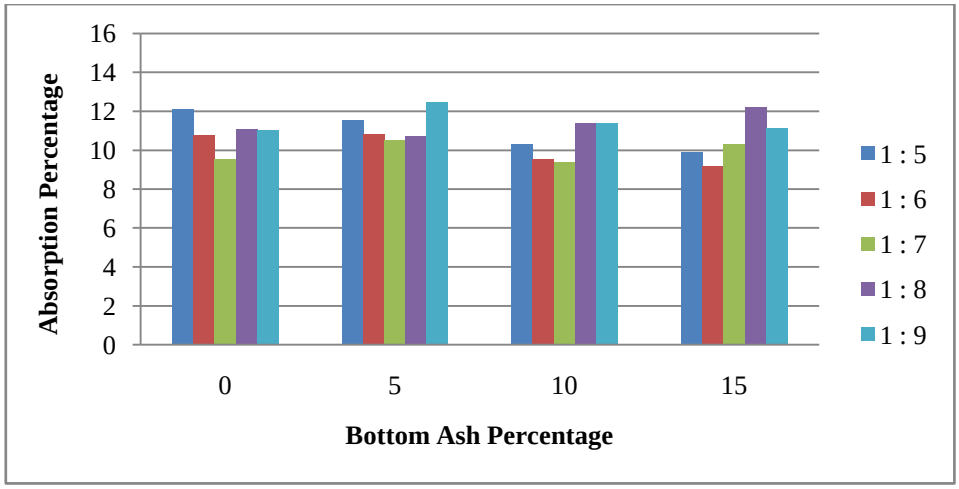

Fig. 7: The relationship between bottom ash and absorption percentage at 30 minutes of interlocking brick.

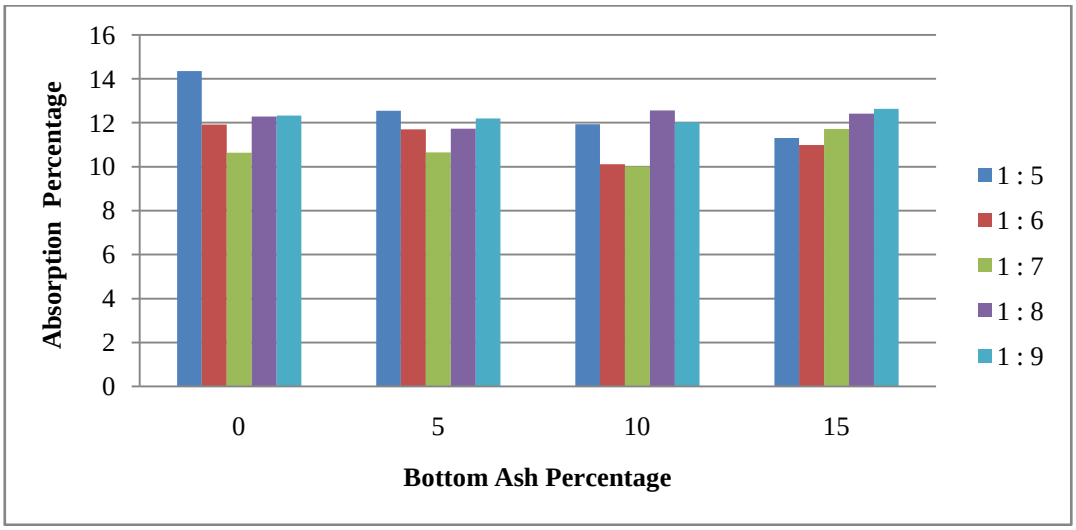

Fig. 8: The relationship between bottom ash percentage and absorption percentage at 24 hrs of interlocking brick.

From figure 7 and 8shows the relationship between bottom ash percentage and absorption percentage at 30 minutes and 24 hrs of interlocking brick found that the absorption percentage of sample was tend to decrease when the ratio of laterite was 1:6. However, added more laterite at ratio 1: 7, 1:8 and 1:9, the absorption percentage of sample was tending to increase.

4. Conclusion:

Tests of engineering properties of interlocking brick which used bottom ash instead of cement at various ratios, can be conclude the result and the suggestion as

4.1 Material properties for interlocking brick:

From the specific gravity of soil aggregate and sand, it has value at 2.66 and 2.44. This value is comparable to the standard of the specific gravity of laterite and sand. The specific gravity and absorption percentage of bottom ash were 2.69 and 1.01.

4.2 Compressive strength and density tests of interlocking brick:

The compressive strength of sample interlocking bricks in each ratio at bottom ash percentage, incubation period of 28 days found that the highest compressive strength is 77.367 kg / m^3 at ratio 1:6. The total of bottom ash was zero percent which is higher than the standard criterion. It showed that such mixing is the suitable ratio in interlocking brick designing. The compressive strength is at least 55.045 kg / m^3 at ratio 1:9. The total of bottom ash was 15 percent which including lot of laterite and had the most of bottom ash which using instead cement. As a result, the compressive strength is lower than the standard criterion. The compressive strength of interlocking brick which added zero to five percent of bottom ash by weigh has the ability to

get maximum strength. If mixed more bottom ash, the value of compressive strength will be decrease which lower than the standard criterion. In case of the ratio of non-bottom ash in the mixture, it will slightly higher than the compressive strength.

The density of the sample is a little bit different. Tends to decrease when add more bottom ash. Because the specific gravity of the bottom ash is less than the specific gravity of cement and the bottom ash is stickier than cement. When mixed the bottom ash in interlocking brick, it will expand, and the concrete has no any clinging. Therefore, when adding bottom ash to replace cement, the density will be decrease but there is a slight difference.

4.3 Interlocking brick absorption test:

The absorption percentage at 30 minutes was the highest value at 12.225 at ratio 1:8., 15 percent of bottom ash. For the absorption percentage at 24 hours was the highest value at 14.348 at ratio 1:5, zero percent of bottom ash. The value of percentage uptake in each sample that is slightly different because of laterite is the main ingredient in each ratio. Thus, the absorption value is not much different. When compare the absorption percentage between 30 minutes and 24 hours in each ratio found that it was slightly increase. Because the interlocking brick is fully saturated since the first 30 minutes. So when immersed in water up to 24 hours, the percentage is not much increasing. The absorption percentage of the sample was tend to decreased when the ratio of laterite was 1:6 but when added more laterite at ratio 1:7, 1:8 and 1:9, the absorption percentage was tended to increasing.

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