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A Study of Coconut Shells As An Additive In The Mixing Brick

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Abstract

The rapid infrastructural development of a country which has creates greater demand of construction material to produce the fast and economic construction. Coconut shell has become the main contributor to the negative effect of environment problem due to poor waste disposal management. Besides, coconut shell waste material are proved that it can be worked in construction industry instead of leave it aside or disposed as landfill. Due to environmental and economic crisis, this study focus on generating product using waste of coconut shells as an additive in the brick concrete that will lessen the environmental issues. İt also paved the way to the recognition of using coconut shells as an additive in the brick concrete. This aims to design a technical specification of brick concrete using coconut shell as an additive in the brick concrete will meet the country environment requirements in order to help contribute to the industry in saving the environment. İt also to encourage the government to find solutions regarding the disposal to landfills and save the environment, to provide new knowledge to the contractors and developers on how to improve the construction industry methods and and to sustain good product performance and meet recycling goals and cost savings. The objectives of this study are to determine the performance engineering of CS bricks which contains additives (coconut shell) by carry out the compressive test and air curing test. Besides, this study also to compare the production cost of CS bricks with additives and common bricks available in market. A conventional concrete brick was compared to CS brick where as the additives percentage in the brick are 0%, 2%, 4% and 6%. Observation from the tests performed were conducted in the laboratory where precise data were gathered and completely attained. The compressive strength of CS brick with coconut shells attained the highest average loads in 4% while the lowest was recorded by a 2% brick coconut shell mixture. Average initial absorption concrete of this study found that each brick shows a different average initial absorption rate. The control specimen recorded the lowest reading while the modified brick with the addition of coconut shell recorded the highest average absorption rate. Besides, the cost of production of CS bricks with additives is cheaper compared to ordinary bricks available in the market. Some of the interesting insights of the study are coconut shells are applicable as an additive in the brick. Also the good indicators of coconut shell quality coconut shells as an additive in the mixing brick are shape and texture, resistance to crushing, absorption and surface moisture. The use of coconut shell in cement sand brick is an alternative to encourage environmental protection in order to minimize waste material.

***Key-words**: Coconut shells, construction materials, cement bricks, recycled materials*

1. Introduction

The rapid infrastructural development of a country which has creates greater demand of construction material to produce the fast and economic construction. The production of bricks is about 1391 billion units in worldwide annual and it is expected that the demand of bricks will continuously rising. By using bricks, the building constructions have high compressor strength and durability in order to protect from foreign disturbance. The advantages of bricks to the structural component of a building are, brick can resist multiple resistance against heat and sound. The bricks components also act as an insulator to the certain part of building component due to the resistance. The building construction can become much easier, faster and cheaper, in term of work ability.

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One of the most accommodating masonry units is bricks, due to its physical, chemical and mechanical properties. Bricks can be classified as one of the back boned of building construction (K Noorhaya, 2015). Malaysia is full with natural waste materials such as agricultural and industrial waste. Those waste can be recycled into useful material, which is into renewable buildings materials. The rising in population, automatically the waste materials and the amount will increase according to the growth in population. Some of the non-decaying waste materials will remain in environment, perhaps for thousand years. The waste materials could cause a crisis, and then contributing to the environmental problems However, to minimize or to overcome the environmental problem is by making a uses of these waste material into a potential material, and helps to maintain a good environments.

According to K. Noorhaya, 2015, the potential of using agricultural waste in buildings construction material has been investigated by various researchers. These automatically will double the advantage, which are disposal of waste material and reduction in construction cost. Malaysia can be categories as a countries where have abundant waste material, those waste material can be used as a potential material in buildings construction. One of the abundant waste materials is a coconut shell. Coconut shell is a form of agricultural solid waste. After the coconut is scraped out from the shell, the shell is usually discarded as wastes. Coconut shell has surface texture which is fairly smooth on the inside and rough on the outside and it is one of the most promising agricultural wastes with its possible uses and it has a good work ability. Coconut shell can be used for construction material application, it would definitely not only beneficial towards the environment, but also can be advantageous for low income families as, it can be used for the construction of low cost houses.

More than ninety three countries have grown a coconut tree. South East Asia is classified as the origin of coconut. According to the Ministry of Agriculture and Argo-based Industry, Malaysia, the achievement and coconut production for year 2015 is 810 million, and it is expected to rise by 400 million to 1,210 million in year 2020. The areas of Primary Coconut Production in Malaysia is in Perak, Selangor, Johor, Sabah and Sarawak.

1.1 Problem Statements

Nowadays, from the aspect of economy in Malaysia shortages of raw materials and the high cost in construction make some people to seek another alternative to save costs and gain more profit. As we know, the use of brick in the wall construction house a rapidly growing because of the cost and convenience. This is evident in projects using brick as the main material in the construction mainly to build the wall.

As the 21st century, approaching there is a greater awareness of the need for materials in an expanding world population and increasing affluence. At the same time, there are aware that our landfills are filling up and our resources are getting deteriorate, our planet is being polluted, non-renewable resources will not last forever, the need on environment friendly materials need to be taken into consideration. Nowadays, there are many issues about bricks. Most of them is the strength of bricks. The main problem in our structure industry, engineer always worried about the bricks and concrete for the long term building that most of the cause is cracking. Cracking can happen to concrete or bricks. It can crack easily. Also the additives used in the bricks mixing is a little bit too pricey. That leads to the problem of cost for bricks**.**

Nowadays people starting to turn into green buildings, a green building come from usage of green materials. One of the green building materials is a brick, the basic brick that we have in construction is a sand brick and clay brick. But to improve the brick, which is by turning the bricks into green bricks, we can add natural waste material from agricultural waste. Green brick is an environmentally friendly, which is not harm to the atmosphere or surroundings. Green brick have an ability to be a light weight bricks, it is because by adding these waste materials will reduce the density of bricks. It is definitely a good result, because we can reduce the load of brick wall on the buildings structure. There are lots of agricultural wastes in Malaysia, one of the wastes are coconut shells. Green brick have been used in most abroad countries, such as India. These waste materials will dispose or dumping in some places if the waste was not treated properly. Dumping will required a place to dump those waste materials. Even though these waste was dispose, but it will take maybe a hundred or thousand years to dispose properly.

The waste materials will become potential materials if it was treated properly. After the coconut being scraped out from the shell, the shell was discarded as a wastes material. From these waste, it could double the advantages as the waste material are turn into potential material and disposal of waste material. One of the ways to improve the waste materials are by turn this waste into a potential materials the potential materials that can be used in building materials. By adding these agricultural wastes into brick mixture can help reduce the environmental impacts, which is by disposing these wastes into a potential building source material. In other countries, the usage of waste materials has been used widely in bricks, concrete and other. Various researchers have been investigated that, there are potential of using agricultural waste in building construction works and helps in reduces the environment problems of solid waste (K. Noorhaya, 2015).

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1.2 Objective of Study

The objectives of this study are:

(a) To study the performance engineering of CS bricks which contains additives (coconut shell) by carry out the compressive test and air curing test.
(b) To compare the production cost of CS bricks with additives and common bricks available in market.

2. Literature Review

Coconut shell is used as an aggregate in concrete, and from the results, it can be concluded that the aggregate has considerable strength as a lightweight aggregate. The researcher was investigated the properties of concrete using the coconut shell as coarse aggregate. In the experimentation, pieces of coconut shell were used as coarse aggregate, the binder was Ordinary Portland Cement (OPC) 53 Grade, and fine aggregate was the river sand. The concrete which was having mixing ratio (cement: fine aggregate: coconut shell) 1:1.60:0.8, 1:1.60:0.7 and 1:1.47:0.65 satisfied the requirement of strength. Results from the experimentation proved that coconut shell fulfils the requirements for use as lightweight aggregate. (Pranav Datar et al., 2017).

In an investigation on coconut shells as aggregate in concrete, the materials used were Portland cement, sand, granite and coconut shells. A concrete mixture of a ratio of 1:2:4 by volume, with a water-cement ratio of 0.6 was used as the control, to which the properties of all other mixes were compared. Coconut shells did the replacement of the granite, 20%, 30%, 40%, 50% and 100% by volume. Results from the experimentation stated that 18.5% replacement of granite by coconut shell gave maximum compressive strength 20 Nmm-2 whereas the compressive strength of concrete produced by 20%, 30%, 40%, and 50% replacement was higher than 15Nmm-2, the minimum recommended for use in reinforced lightweight concrete construction. In a review of Combination of coconut shell and grained palm kernel as lightweight aggregate in concrete, it was concluded that Combination of coconut shell and grained palm kernel had potential to be used as lightweight aggregate in concrete. It also reduced the material cost of construction because of the low cost and abundant availability of these agricultural wastes (Siti Aminah et al., 2019).

The study of coconut shell used in the bricks is gaining an importance in terms of possible reduction of waste product in the environment and finding a suitable alternative for renewable natural waste material. In this research, a coconut shells are collected from the local vendor. The particles size of the coconut shells range from 25 mm to 30 mm. From all these references it was clear that except in concrete and for the composite material, coconut shell has not been used commercially. So it was decided that to go for a new application and check the feasibility of coconut shell powder to be used as aggregate in construction bricks.

3. Methodology

The motives of this research are to outline the research methodology of this study, explaining on the waste material, the apparatus and procedure, and design properties that will be defined by undergoing necessary testing and analysis. In the experimentation, pieces of coconut shell were used as coarse aggregate, the binder was Ordinary Portland Cement (OPC) 53 Grade, and fine aggregate was the river sand.

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3.1 Flow Chart of Methodology

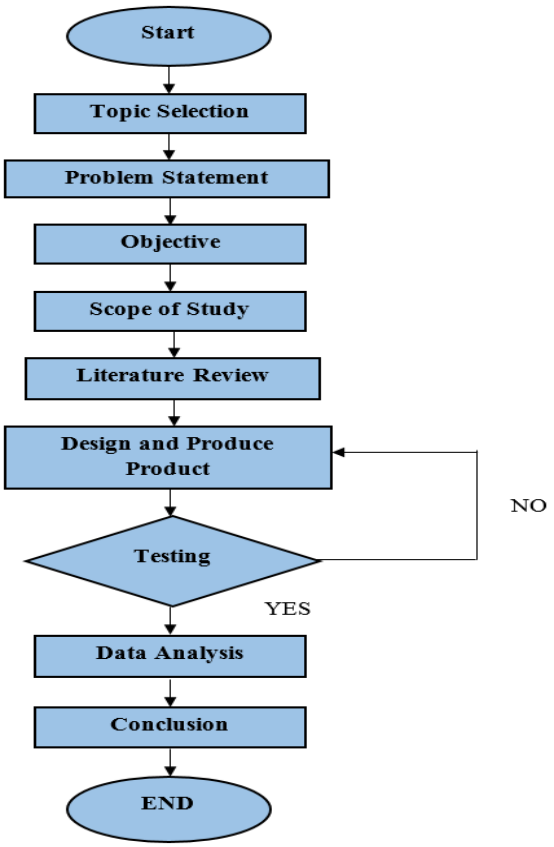

Figure 1 Flow Chart of Methodology

3.2 Cement Sand Brick Design

The cement sand brick are designed as shown in figure below. This dimension is used so that it can be stacked overlapping and certain patterns to support heavy loads. The dimensions of the brick is 216 mm x 103 mm x 65 mm. This brick is made from a mixture of cement, coconut shells and sand with a ratio of 1:8 for control brick. The water content in the mixture should be controlled so as not too wet. Cement bricks manufactured by using a mold. The freshly printed brick allowed to dry and preserved for two weeks before it is suitable for use.

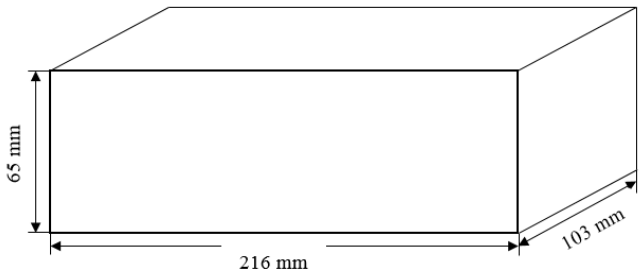

Figure 2 Cement Sand Brick Design

3.3 Sampling Testing

Results data from experiments on concrete brick samples taken from several different concrete brick samples are reported in the form of appropriate tables using Microsoft excel. The comparison of the results between different cement bricks for all the following experiments is reviewed and reported in graphical form also using Microsoft excel.

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This crushed coconut shell will be used as an additive in concrete brick mixing with a ratio of 1: 8. The crushed coconut shell will undergo a test which is a sieve test. In this sieve test, this crushed coconut shell should have exceeded the 4.75mm sieve size. After the crushed coconut shells through the sieve test it will be weighted according to their weight to be incorporated into the concrete brick mixing using 0%, 2%, 4% and 6% coconut shells.

The concrete brick that will be added to the coconut shell is divided into 4 sample segments 0%, 2%, 4% and 6% coconut shell additive. These 4 samples will undergo air curing test for 7 days, 14 days and 28 days. The sample was completely cured to be tested in the laboratory to identify the characteristics of quality. There are two testing laboratories have been accredited for the purposes of this test. Table 3.2 shows the location of the laboratory used for testing.

Table 1 Testing Laboratory Locations for Concrete Brick Samples

No.	Laboratory	Testing
1.	Concrete Laboratory of Polytechnic Merlimau Melaka	Air Curing Test
2.	CMCS Engineering Specialist Sdn. Bhd.	Compressive Test

The compressive loading test on concretes were conducted on a compressive testing machine of capacity 2000 kN For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516-1959. The test was conducted on 150mm cube specimens at 7, 14 and 28 days. The brick curing process, usually done naturally, where moisture in the air is used to control the cement hydration by organizing and aerating bricks as soon as it is brewed and inserted into the mold. The strength of the brick will build slowly and the important thing to note is to avoid drastic drying of the resulting bricks because these bricks need to be treated in the air around which the best air humidity is at least 70% to allow optimum hydration of the cement used for 28 days.

3.4 Concrete Brick Mix Ratio and Control

In general, the ratio for control concrete brick and modification is at 11%: cement and 89%: sand. The use of coconut shell as a sand additive in brick mixing is made at three percentages at 2%, 4% and 6%. This percentage is derived from research in literature studies. Researchers use this percentage because this percentage is the percentage of the most effective percentage of coconut shell together with sand. Table 3.3 shows the amount of material in each control of concrete and control concrete brick.

Table 2 Mixture of Concrete Brick Control and Coconut Shell Ratio

Percentage of Mixed Material in Concrete Bricks	Cement (kg)	Sand (kg)	Coconut Shell (kg)
Control	11 %	89 %	0 %
	0.165	1.335	-
2 %	11 %	87 %	2 %
	0.165	1.335	0.03
4 %	11 %	85 %	4 %
	0.165	1.335	0.06
6 %	11 %	83 %	6 %
	0.165	1.335	0.09

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4. Results and Discussion

4.1 Dimension Tolerance

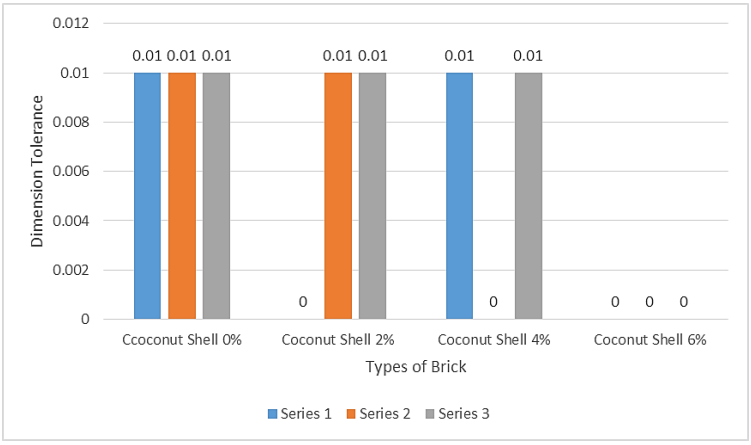

Figure 3 Dimension Tolerance for Bricks

In conclusion, the dimension tolerance decision on each concrete brick sample produced by the researcher varies from dimension length, dimension width and thickness dimension. This is because the method of making concrete bricks is not so perfect because of the fact that the mixture is manually and has no brick-and-mortar machines or machines.

4.2 Density

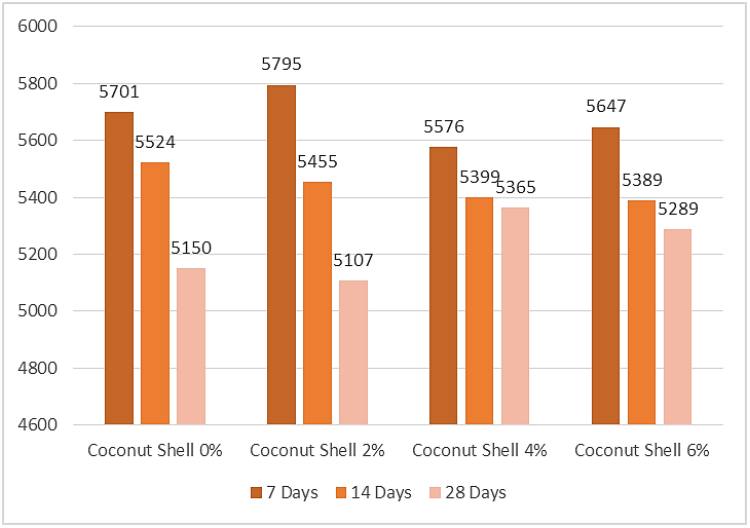

Figure 4 Average Density of Concrete Bricks

According to most studies, sand-bricks generally have a density of 1500kg / m3 to 2000kg / m3. In general, all concrete bricks either controlled or modified bricks record the density as suggested. The average density difference between all bricks studied is shown in Figure 4.2. The density of a brick is much influenced by the work of brick compacting. Usually the higher the level of compaction strength of a brick, the higher the density. Although compaction techniques are different from brick making factories, the density comparison between the control specimen and the modified brick is not much different. This is because the researchers use manual compression techniques.

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The dough ratio is also a factor that affects the density of a brick. This can be observed in control bricks that record lower density than modified bricks. This is because, the composition of the control brick ratio of the control and the modified brick has been different in terms of sand ratio. In the modified brick ratio, the ratio of sand has been reduced because it will be replaced by coconut shell as an additive in this experiment.

The workability of fresh brick batons also plays a role in determining the density of the bricks. A brick batter with good workability will encourage high-density brick production. This factor explains the existence of the density differences occurring among all the bricks studied. The workability of fresh concrete brick batches depends largely on the ratio of cement water to which this ratio differs from each mix. The analysis of density differences shows that the use of coconut shells in concrete bricks affects the workability proved by the highest density record compared to other bricks, especially with control specimens.

4.3 The Initial Absorption Rate

The initial absorption rate of a brick is very important in determining the bonding stability of a brick. The strength of bonding between concrete bricks greatly influences the mortar strength used. The physical design of concrete bricks with relatively large cavities involves the use of larger mortars. Hence, the loss of sufficient amount of water for cement reactions in mortar due to initial absorption by bricks should be assessed to assess the stability of concrete brick reinforcement.

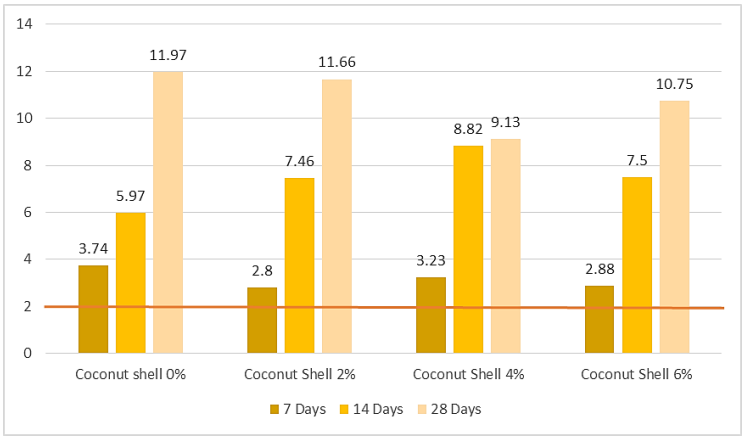

Figure 5 Average Initial Absorption Concrete of Study

Based on the graph above it is found that each brick shows a different average initial absorption rate. The control specimen recorded the lowest reading while the modified brick with the addition of coconut shell recorded the highest average absorption rate. The above graph also shows that all the bricks studied recorded an average absorption rate that exceeded the maximum initial absorption recommended by the previous researcher. The difference in average values of initial absorption that occurred between each brick 0%, 2%, 4% and 6% occurred because the bricks were made using the manual method. This situation led to a difference in the properties of the brick itself, including the initial absorption ratio. The 0% specimen was also found to meet the recommended initial absorption rate as the material selection, mixing and production process was controlled as much as possible. This situation indicates the use of coconut shells can help to obtain good initial absorption rates.

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4.4 Compressive Strength

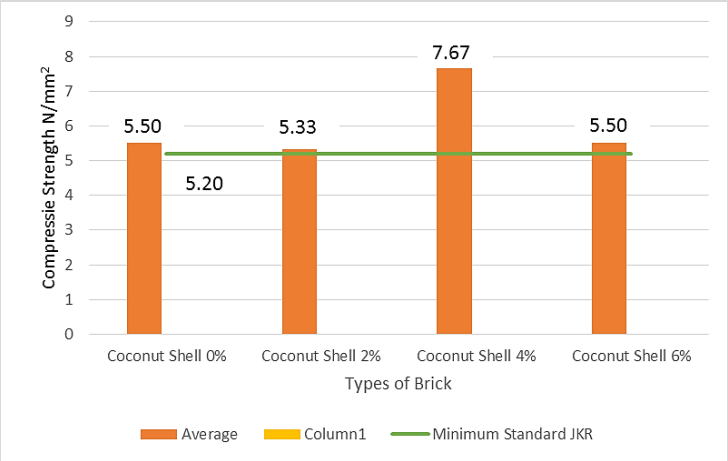

Figure 6 Differences in Compressive Strength between Brick Each

From the figure above the highest strength was recorded by a 4% brick coconut shell mixture while the lowest was recorded by a 2% brick coconut shell mixture. The specimen-controlled child's preparation process recorded results exceeding the JKR standards. The graph above shows that the use of coconut shells affects the strengthening of strength.

4.5 Cost of Product

This brick is made by sand, cement and coconut shell. Researcher the list of material and tools has be done in factories producing bricks. The materials to be used have been selected to conduct this study. Cement to be used are Portland cement, the current market price for cement is RM 18.00 for 50 kg. Besides that, fine sand price is RM130.00 for a lorry and coarse sand is RM 100.00 for a lorry. For coconut shell not have cost because the researcher take a coconut shell from the dump site of coconut shell at Pasar Besar, Seremban, Negeri Sembilan. Estimated value the size of coconut shell that has been crushed is 3.38 mm. The total cost used to prepare this brick based on table 3.4. Besides, the cost of production of CS bricks with additives is cheaper compared to ordinary bricks available in the market.

5. Conclusion

Most of the concrete bricks made by the researchers manually record the uniform size dimensions and permissible tolerances. The density of the concrete brick control and modification varies depending on the ratio of the mixture used but all samples have a normal density of concrete bricks that are stabilized by cement. The use of coconut shells has an effect on increasing the density of a brick at the same time indicating an increase in the degree of workability of the blend. Moist absorption rates for all study bricks are at a satisfactory level according to their use. The type of sand is also a dominant factor affecting the moisture absorption rate of a concrete brick. Generally all study bricks recorded the lowest normal compressive strength of cement stabilized concrete bricks. The use of coconut shells affects the increased strength of compression. The use of coconut shells as a whole has a positive effect on the improvement of physical and mechanical performance of concrete bricks. The type and nature of sand used greatly influence the physical and mechanical properties of concrete bricks.

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