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THE STUDY OF HYDROXYAPATITE IN CLAMSHELL TO ENHANCE THE QUALITY OF BRICKS

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Abstract

This study is to add hydroxyapatite in clamshell as an additive inside the concrete brick. The objective of this study is to determine that hydroxyapatite can help to produce better quality concrete bricks in terms of its strength and infiltration rate. The scope of research for these projects is the strength of the bricks and the infiltration rate after adding Hydroxyapatite, a comparison between burnt brick and brick that contain Hydroxyapatite which produces without burning it, the synthesis of calcium carbonate to calcium phosphate and the characteristic of the shell. The ratio of Hydroxyapatite in making a complete brick is 1:2:4:1. The ratio of cement, sand, aggregate, and water is fixed so that the product will not be disturbed by other mixtures while the ratio of Hydroxyapatite changed on each mold where mixture A 100 g HAp, B 200g HAp, C 300g HAp. It can be seen that bricks that contain HAp slurry in the range of 100g of HAp have a lower infiltration rate than concrete brick points that do not contain HAp while in terms of strength, bricks that contain HAp slurry have lower strength compared to the control brick point, but still within the target strength which in range of 43.94 N/mm².

Keywords: Concrete Bricks, Hydroxyapatite, Clamshell, Strength, Additive

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1.INTRODUCTION

This study is to add hydroxyapatite, which is in clamshells as an additive inside concrete blocks. The addition of this material is to test whether it can increase the strength of the concrete block. This is because concrete bricks have low compression strength and tend to be of low quality. While these bricks can be used for fences and internal brickwork to their minimal maintenance requirements, noise reductions, and heat resistance qualities. Concrete brick is not always readily accepted in some parts of the industry, so adding Hydroxyapatite to the ingredient of concrete brick will help to expand the range of use of concrete brick. The higher cost of concrete brick production can be reduced by replacing the ratio of cement with hydroxyapatite slurry and no heating is needed. There are a lot of waste shells that can be found at the beach or landfill. Waste shells can be utilized by using it in the production of bricks.

The aim of this study is to determine that Hydroxyapatite can help to produce better quality concrete bricks. Besides to produce unburned brick using Hydroxyapatite slurry as an additive and help to reduce cost production and environmental protection purpose also help to manage the shell waste disposal wisely.

The scope involved in this work is the strength of the concrete bricks after adding Hydroxyapatite slurry, infiltration rate after Hydroxyapatite slurry is added, comparison between burnt brick and unburnt bricks, synthesis of Hydroxyapatite slurry, the characteristic of the shell used in this study.

2.SUMMARY LITERATURE REVIEW

The shell has a calcium carbonate (CaCo3) the nature of that just as lime makes it suitable for use in construction where if shells are mixed into the brick mix, it can increase the strength in the mixture. The CaCO3 helps to increase the early strength, due to the accelerator effect and high rate of hydration which hardens the concrete quicker. At matured age, the concrete with the CaCO3 addition exhibits lower strength as compared with concrete without CaCO3, but still within the target strength. Brick is one of the most durable construction materials available. They are a low-maintenance option for most types of buildings, but they are susceptible to extreme weather conditions. Building with bricks is also time-consuming and labor-intensive. Bricks are incredibly strong; known as a load-bearing material they can fully support a building. Hydroxyapatite (HAp) is a kind of bioceramic-based material that has been used extensively in many medical applications. Owing to nearly similar mineral contents to natural bone, the material has been accepted as an implant to improve osteointegration with the bone tissue. In this work, an alternative processing route from waste materials, namely clamshell in producing HAp powder is presented.

2.1.Synthesis of Hydroxyapatite

Materials containing calcium carbonate (CaCo3) can be used to produce calcium phosphate (Ca (PO4)2) can be found in clamshells. The chemical precipitation method can be used to produce calcium phosphate by reacting calcium carbonate with phosphoric acid.

Chemical Precipitation Method

$$CaCO_3 \rightarrow CaO$$

The clamshell powder which is calcium carbonate (CaCo3) is then oxidized for 3 hours to remove organic matter and turned it into calcium oxide (CaO).

$$CaO + H_2O \rightarrow Ca(OH)_2$$

The powder is mixed with distilled water to transform it into calcium hydroxide (Ca (OH)2).

$$Ca(OH)_2 + H_3PO_4 \rightarrow CaO\ (PO_4)(OH) + H_2O$$

Phosphoric acid (H3PO4) was added little by little into the calcium hydroxide (Ca (OH)2) slurry and stirred until it reached the pH range which is between 6.5 and 8.5 to produce hydroxyapatite (HAp)

3.METHODOLOGY

3.1.Process flow for synthesis CaCO3 to CaO

The process flow below explains the process for the synthesis of Calcium Carbonate to Calcium Oxide for this project. The Calcium Carbonate is gained from the clamshell and we synthesize this calcium carbonate into Calcium Oxide by heating the clamshell for 3 hours at a temperature 900 degrees Celsius. The heating process remove the organic matter and turned it into Calcium Oxide. Together we attach the picture of the process flows as an illustration.

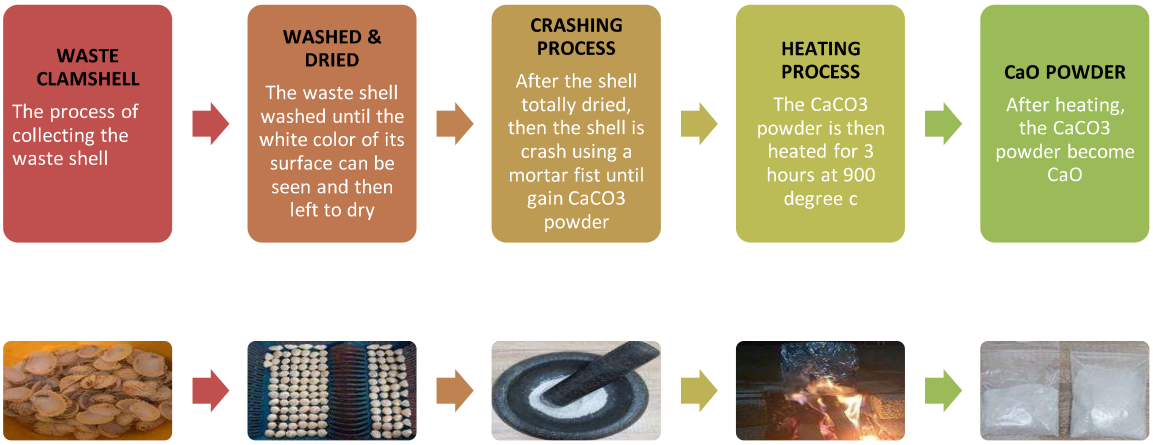

Figure 1. Process flow for synthesis CaCO3 to CaO

3.2.Process flow for synthesis of Hydroxyapatite slurry

Process flow below explain about the process flow for synthesis of the Calcium Oxide to Hydroxyapatite slurry.

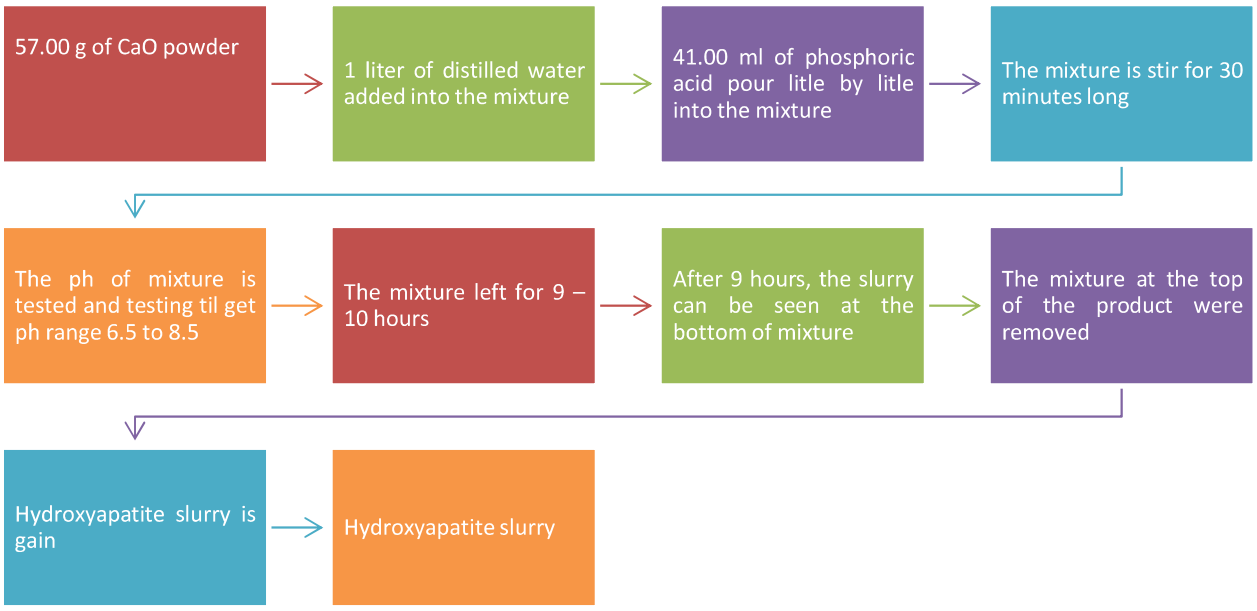

Figure 2. Process flow for synthesis of Hydroxyapatite slurry

3.3.Process for Concrete Brick Gred 20P

Process flow below explain about the process flow for process of Concrete Brick Gred 20P. This gred of brick are used in this study while this gred also is a industrial gred uses.

This study follows the standard dimension of industrial brick and ratio of brick gred 20P. We produce 3 sample of brick with standard dimension and ratio of water, sand, cement, aggregate and we added Hydroxyapatite as an additive with different ratio in each sample. This is to do the analysis on the bricks.

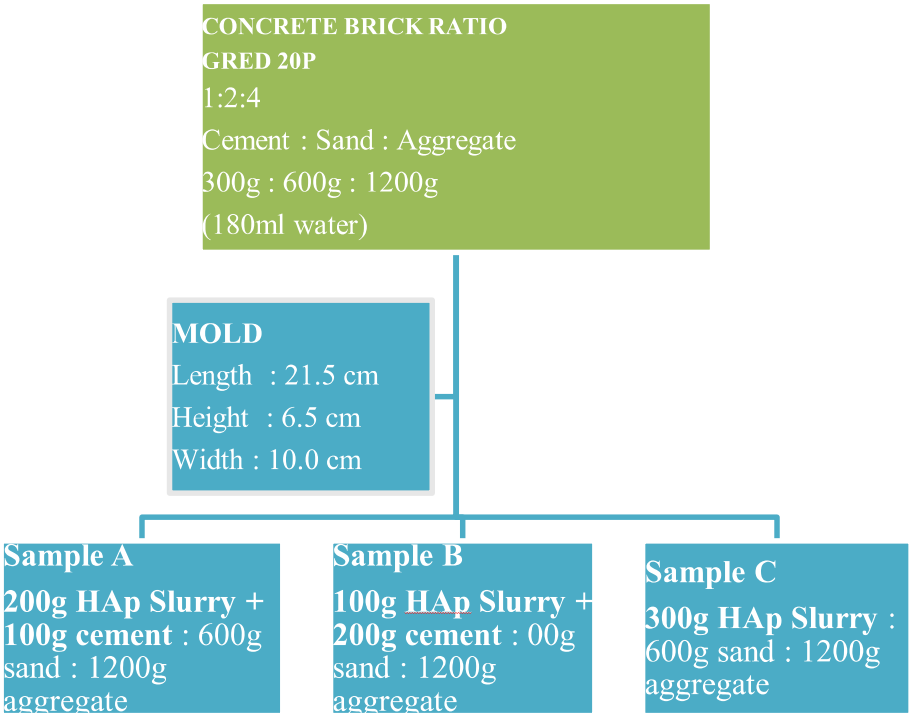

Figure 3. Process for Concrete Brick Gred 20P

4.RESULT & DISCUSSION

4.1.Strength Testing

For the scope of strength, we are producing 7 concrete brick blocks in total whereas samples A and B both consist of 2 concrete brick blocks with the same ratio because they will be tested on 7 days and 14 days. We also made a control brick point with a ratio of 1:2:4 which 300 g of cement, 600 g of sand, and 1200 g of aggregate with water 180 ml. The purpose of this control brick point is to test the different strengths of concrete brick and concrete brick that were added to hydroxyapatite slurry. We will compare the strong result and do the analysis. We also make this control brick point 2 blocks in total because it also will be tested on 7 days and 14 days. This strength test is conducted at GeoSpec Sdn Bhd using 100Kn Concrete Brick Compression Test Machine. The result is shown in Table 1.

Table 1. Result for Strength Result Test

Sample		Compressive Strength
	Sample A	35.62 N/mm^2

7 days	Sample B	$24.20\ N/mm^2$
	Control Brick Point	$44.31\ N/mm^2$
14 days	Sample A	$43.94\ N/mm^2$
	Sample B	$36.32\ N/mm^2$
	Control Brick Point	$48.33\ N/mm^2$

In Table 1, we can assume that the concrete brick with the hydroxyapatite slurry exhibit lower strength as compared to the control point brick. However, we can see that the strength still increases from day 7 to day 14 is increase. According to the previous study, the CaCO3 helps to increase the early strength, due to the accelerator effect and high rate of hydration which hardens the concrete quicker. At matured age, the concrete with the CaCO3 addition exhibits lower strength as compared with concrete without CaCO3, but still within the target strength which is 49N/mm².

4.2.Infiltration Testing

The purpose of this test is to know how long the concrete brick will absorb the water with a specific volume which we fixed to 100ml of water. Commercial concrete brick absorbs water faster than concrete brick that contains HAp and this shows that brick that does not absorb more than 20% is good.

For the infiltration scope of the study, we are making 6 blocks of concrete brick Sample A consist of 2 blocks, sample B consists of 2 blocks. This is because the infiltration test will be conducted at 7 days and 14 days and this infiltration rate test cannot use the same concrete for 7 days and 14 days because the density after getting wet is different. Moreover, we also made a control brick point to compare the result of the infiltration rate for concrete brick with the additive of Hydroxyapatite and without the additive of Hydroxyapatite in concrete brick.

For the infiltration rate test, we are preparing a circle cup to put at the top of the concrete brick surface and covering all the space around the circle cup to make sure no water will spill out. Then, after covering all, 100 ml of water will pour into the circle cup and the time will start to calculate how long the water will absorb into the concrete brick. This step is the same for all concrete brick samples and for control brick points. The result is shown in Table 2.

Table 2. Result for Infiltration Rate Test

Sample		Infiltration Rate
7 days	Sample A	79.28 in/hr
	Sample B	101.93 in/hr
	Control brick Point	1698.84 in/hr
14 days	Sample A	149.27 in/hr
	Sample B	178.38 in/hr
	Control Brick Point	1049.29 in/hr

In Table 2, we can see the brick that contains 100g of HAp slurry in 7 days is the best concrete because it has a lower infiltration rate. The lower the infiltration rate, the good brick it can be commercialized. It contains 200g of cement and 100g of HAp slurry which means the cement function as a binder with the help of Hap slurry which makes it lighter and have a lower infiltration rate. This is a good combination of the ratio.

4.3.Comparison between burnt brick and unburned brick

When compared to unburnt brick, burnt brick has a higher strength. However, in this study, our objective is to

prove that adding hydroxyapatite as the ingredient of making burnt brick, will produce better quality concrete bricks. From what we knew, as for the burnt bricks, to meet the mechanical indicators, it is necessary to use high temperatures to have enough solidity. While as for the unburnt bricks, after the material is put into the brick mold, it will cure itself and still achieve the mechanical requirements such as compressive strength and a better infiltration rate after adding the hydroxyapatite. The result is shown in Table 3.

The table below explains the weight differences between burnt brick and unburnt brick that contain HAp after 7 days and 14 days. As can be seen, the brick that contained HAp after 7 days of being dried and containing 100g of HAp was lighter than burnt brick. Burnt brick is stronger than concrete and many building materials and this study want to prove the effect of adding HAp into a concrete brick in term of its weight only.

Table 3. Compares the Result

<table>
<tr><th>Burnt Brick</th><th colspan="2">Unburnt Brick</th></tr>
<tr><td rowspan="4">2.72 kg</td><td>Sample A
(7 days)</td><td>Sample A
(14 days)</td></tr>
<tr><td>1.976 kg</td><td>2.049 kg</td></tr>
<tr><td>Sample B
(7 days)</td><td>Sample B
(14 days)</td></tr>
<tr><td>2.014 kg</td><td>2.011 kg</td></tr>
</table>

4.4.Characteristics of shell used in this study

The shell that we used in this study is known as Blood Clamshell or the other name is Anadara Grakosa/Tegillarca Granosa. This shell lives mainly in the intertidal zone at one to two meters of water depth, burrowed down into sand or mud. Besides, there are 5 groups of this shell. To synchronize our project work, we are using group 1 of the shell.

Group	Size (mm)
1	20 – 30
2	31 – 40
3	41 – 50
4	51 – 60
5	61 - above

Table 4. Chemical Composition of Blood Clamshell Powder (Anadara Granosa)

Component	Content (% by weight)
Calcium Carbonate (CaCO3)	98.7
Sodium (Na)	0.9
Phosphorus (P)	0.02

Magnesium (Mg)	0.05
Ferum (Fe) Cuprum (Cu) Nikel (Ni) Boron (B) Zink (Zn) Silicon (Si)	0.02

Based on these chemical compounds, blood clams can be used as an alternative to the main raw material or substitute material for making calcium phosphate. Blood clam shells also can be optimized as raw material for making environmentally friendly calcium phosphate. Furthermore, blood clam shells have the same hemisphere attached to each other at the boundary of the shell, and ribs on both halves of the shell are very prominent. The shell is slightly longer than the height of the protrusion.

5.CONCLUSION

The main purpose of this project is to study Hydroxyapatite in clamshells to enhance the quality of bricks. As conclusion of this project, brick that contains Hydroxyapatite as an additive can produce a better quality of brick in terms of its infiltration rate. This is because bricks that contain HAp slurry have a lower infiltration rate than concrete brick points. On the other hand, in terms of strength, bricks that have been mixed with HAp slurry have lower strength compared to the control brick point. Despite that, the sample bricks that contained hydroxyapatite seem to be lighter than the control brick point. In addition to this, the sample bricks which contained HAp also have a whiter and smoother surface than the industrial concrete bricks. Over and above this, by doing this project we managed to produce unburned bricks that contained hydroxyapatite slurry as an additive. For good measure, by using hydroxyapatite slurry we can reduce the cost of cement used if it is produced in large quantities. Finally, the objective of environmental protection purposes is obtained because of using waste clamshells.

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