

# A Preliminary Study On Chemical And Physical Properties Of Coconut Shell Powder As A Filler In Concrete

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**Abstract.** Coconut Shell Powder were obtained from coconut shell that had been discarded and grinded until it become in a form of powder. This study were conducted to determine the chemical and physical properties of coconut shell powder to be used as a filler inside concrete. In order to do that, an experimental setup of X-Ray Fluorescence (XRF), Particle Size Distribution, Scanning Electron Microscopic (SEM), Density, and Specific Gravity were conducted. The coconut shell powder consist mostly carbon (C) and potassium oxide (K<sub>2</sub>O). The presents of silicon dioxide (SiO<sub>2</sub>) is crucial in order to be mix with concrete. The size of the coconut shell is ranging from 600 $\mu$ m and below. From all the testing, it is show that the coconut shell powder can be use in mixing with concrete as a filler.

## 1. Introduction

The application of concrete material in construction industry were highly demand which growing rapidly demonstrate the need for various types and properties of concrete to meet the diverse needs of the user [1-2]. Normally, the quality of concrete with high durability properties can be generated by consideration of the composition of the materials used such as cement, sand, aggregates or water. Besides that, mix design and the way of production like mixing, transporting and pouring concrete is also the factors to get a better quality of concrete [3-6]. Recently, the sustainability in construction is one of the efforts that have been practiced by developed countries to create more healthier environment and to reduce the environmental impact of a building over its entire lifetime, while optimizing its economic viability and the comfort and safety of its occupants. One of the steps that can be practice is to use materials that are categorized as agricultural waste material in concrete manufacturing. The use of agricultural waste in construction industry holds a high potential of reducing global environmental pollution [7]. Agriculture waste have many advantages. Some of the advantages are, high specific strength and modulus, low density, renewable nature, biodegradability and absence of health hazards [8]. Their usage for improving the properties of the composites costs very little when comparing with other construction materials [9]. Coconut shell, oil palm shell, oil palm clinker, corncob ash, and rice husk ash are agricultural by product. Although some of these materials can be used as animals food or fuel in biomass power plants or in boilers of various industrial sector to produce steam, a lot of these materials are still disposed off into landfill or burnt caused environmental problems [10]. For eliminating or reduce the negative environmental impact of the concrete industry, the use of industrial wastes as materials for mixing concrete considered as an alternative solution to prevent excessive consumption of



raw materials and indirectly promoting environmental sustainability of the industry [11]. Based on previous studies, coconut shell was used as an aggregates replacement in the manufacture of lightweight concrete [12-14]. However there are lack of research on the coconut shell used in term of the size of powder. Therefore, this paper will emphasize on the chemical and physical property of coconut shell powder to be used as a filler in a concrete since the coconut shell is a part of agricultural waste.

## 2. Coconut

Coconut shell is one of the solid disposal wastes that came from agricultural activities. The used of coconut shell as one of the composite materials in the production of concrete driven by the problem caused by the disposal of solid waste. Coconut shell represents more than 60% of the domestic waste volume and had a serious disposal problem for local environment [15]. However, these wastes can be used as potential material or replacement material in construction industry. Besides that, coconut shell are potential candidates for the development of new composite material in concrete mix design because of their high strength and modulus properties [16].

Coconut is grown in more than 90 countries in an area of 14.231 million hectare with a total production in terms of copra equivalent of 11.04 million tonnes (MT). Indonesia (25.63%), the Philippines (23.91%), and India (19.20%) are among major coconut-producing countries in the world [17]. Apart from that, the usage of coconut shell in concrete are much cheaper as it is an agricultural waste that was dumped and not been use. A better and a green environment can be created by using this coconut shell [18]. In this paper, the coconut shell were being analyzed in the form of coconut shell powder. The method and the testing involve are being discussed in the next subchapter.

## 3. Materials And Method

### 3.1. Raw Materials

The coconut shell powder were collected from the factory that is located in Selangor, Malaysia. Before it were turns into powder, the coconut shell was sun dried and shredded into small pieces and were grinded until it become powder. The final product were obtained in the size of  $63\mu$  and below. Figure 1 shows the shredded coconut shell while Figure 2 shows the coconut shell after being grinded and become a coconut shell powder.



**Figure 1.** Shredded Coconut Shell



**Figure 2.** Coconut Shell Powder

#### 4. Experimental Setup

There are 5 type of experimental were conducted to study the properties of coconut shell powder.

##### 4.1. XRF

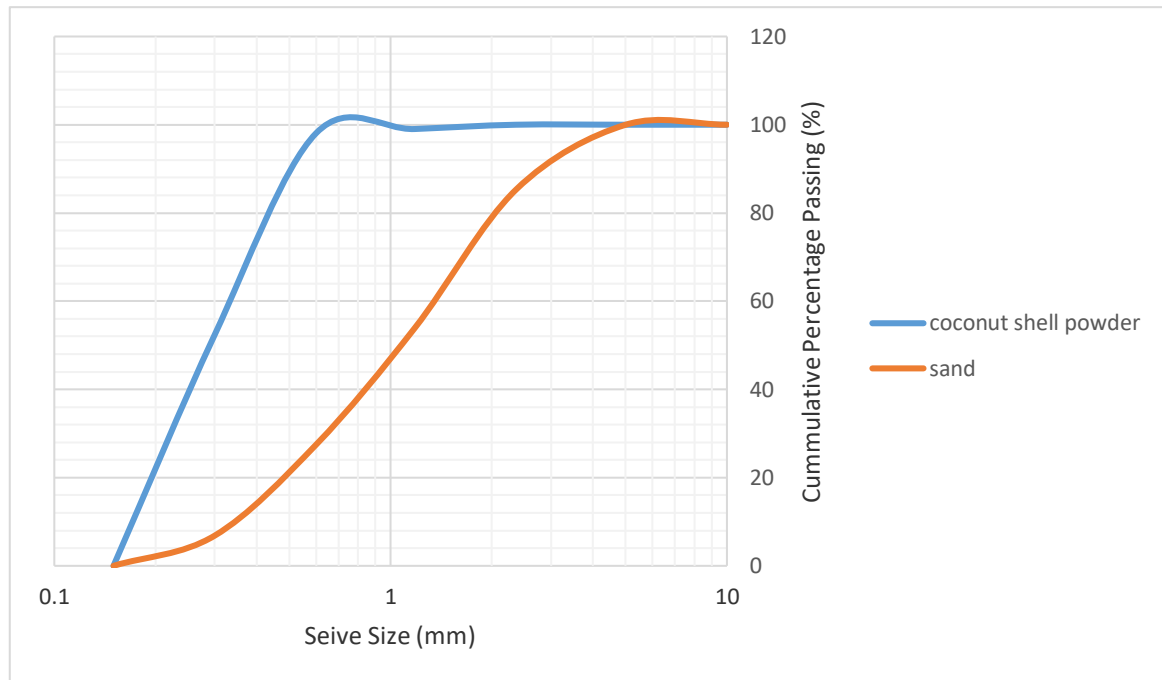
The chemical composition of coconut shell powder were obtained by doing the X-Ray Fluorescence (XRF). Table 1 shows the data obtained. The data shown a list of chemical compound that found inside the coconut shell powder. Most of the compound are commonly found inside concrete. Therefore the usage of coconut shell powder as a filler added inside the concrete will improve the properties of concrete.

COMPOUND	FULL NAME	CONCENTRATION
<b>Coconut shell powder (g)</b>		5
<b>Wax (g)</b>		5
<b>C</b>	Carbon	10.00 %
<b>K2O</b>	Potassium Oxide	1.21 %
<b>SiO2</b>	Silicon Dioxide	0.98 %
<b>Cl</b>	Chlorine	0.79 %
<b>Fe2O3</b>	Iron(III) Oxide	0.35 %
<b>MgO</b>	Magnesium Oxide	0.31 %
<b>Na2O</b>	Sodium Oxide	0.29%
<b>CaO</b>	Calcium Oxide	0.23 %
<b>MoO3</b>	Molybdenum (VI) Oxide	0.17 %
<b>S</b>	Sulphur	0 < LLD
<b>Al</b>	Aluminum	0 < LLD
<b>P</b>	Phosphorus	0 < LLD

**Table 1.** XRF Data Of Coconut Shell Powder

#### 4.2. Particle Size Distribution

The testing were conducting by sieving the coconut shell powder using the sieve size 10mm, 5.0mm, 2.36mm, 1.18mm, 600 $\mu$ m, 300 $\mu$ m, 150 $\mu$ m and pan. Figure 3 shows the data obtained and were compared with sand.

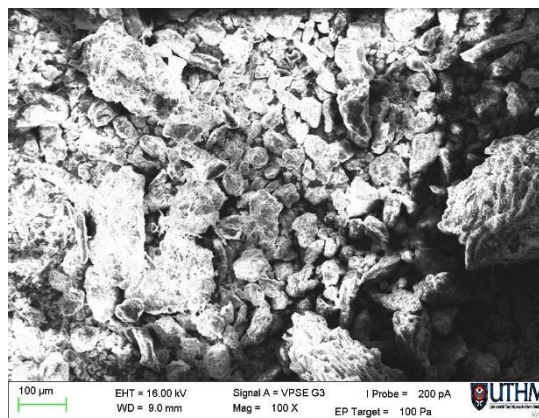


**Figure 3.** Particle Size Distribution Of Coconut Shell Powder Compared With Sand

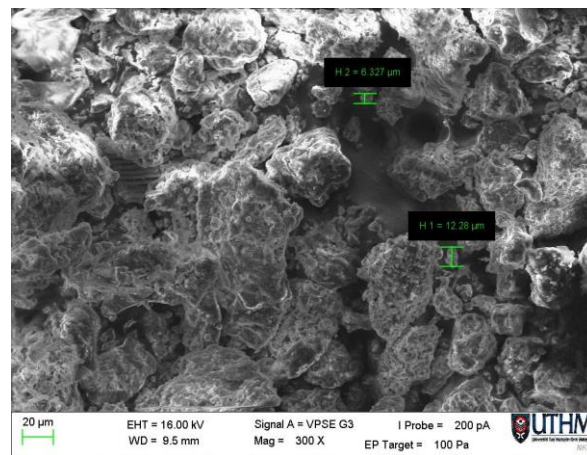
From the graph obtained, the particle size of coconut shell powder is much smaller than sand. It shows that coconut shell powder is suitable to be used as a filler inside concrete. Since it is smaller in size, it can fulfill the space between the sand and thus changes the performance of the concrete.

#### 4.3. SEM

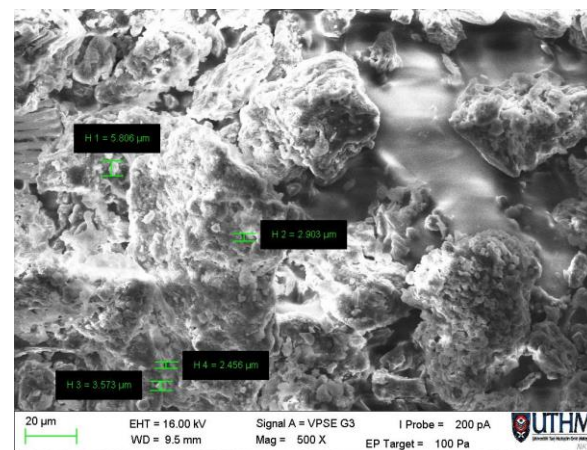
Scanning Electron Microscopic (SEM) were conducted in order to see the clearer version of coconut shell powder under 100, 300 and 500 times zooming. Figure 4 until Figure 6 shows the particle image under certain times of zooming.



**Figure 4.** Particle image of coconut shell powder under 100 times magnifier



**Figure 5.** Particle image of coconut shell powder under 300 times magnifier



**Figure 6.** Particle image of coconut shell powder under 500 times magnifier

## 5. Result And Discussions

All the testing results that were conducted and mentioned above on the sample of coconut shell powder were presented as follow. From the Table 1, the result of XRF shows that the higher percentage of element that can be noticed are Carbon and Potassium Oxide which is 10.00% and 1.21% respectively. Other element that are contained inside coconut shell powder were less than 1.00%. However, the presents of Silicon Oxide were crucial as it is the most important element that is needed when mixing with concrete. For this coconut shell powder it is noticeable that the presents of silicon oxide is 0.98%. Next is the particle size distribution conducted using sieve analysis method. From Figure 3, it can be noticed that the coconut shell powder consists of particle diameter which is 600 $\mu\text{m}$  and below. To be a filler, the material need to be in the form of very fine particle and the coconut shell powder have it all. Most of the particle is less than 150 $\mu\text{m}$  which is good to be used as filler. For a better image and size of the coconut shell powder, the Scanning Electron Microscopic (SEM) test were conducted. Although from the bares eyes, the coconut shell power look very fine, the particle is actually look like a fiber after being zoom at 500 times magnifier. This shows that, the particle are fine, angular and fibrous material.

In term of colour, coconut shell powder were in brownish. The colour were in its natural state. The density of coconut shell powder is  $472.593 \text{ kg/m}^3$  that is far more less than sand which is  $1506.667 \text{ kg/m}^3$ . Lastly the specific gravity obtained for coconut shell powder are 1.433. The data obtained showed that coconut shell powder can be used in mixing with concrete as a filler

## 6. Conclusions

From the testing that had been conducted, coconut shell powder are surely a best agricultural waste to be used in concrete. All the data given shows that the coconut shell powder will react as a filler inside the concrete. Further research need to be conducted to see the performance of concrete filled with coconut shell powder.

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