A Comparative Study between the Thermal Insulating Property of Cement Mixture Compound, Plywood, and Cement infused with Chicken Feathers and Clay Soil Mixture Compound

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Abstract. The Philippines is one of the countries that experience hot weather throughout the year and are exposed to negative effects of heat. This study focuses on alleviating the heat experienced indoors by reinforcing chicken feathers to your normal cement mixture. The reduction of the heat experienced indoors will lead to cost savings for if the surrounding temperature indoors is cool enough, one will not have to use an air conditioner or even an electric fan. Related studies about heat, insulation, cement, and the uses of chicken feathers in various industries also became the support and basis in pursuing this study. The researchers aimed to produce a cement mixture with chicken feathers that will effectively insulate a structure. Comparison between the temperature inside the cement model with the commercially available cement mixture and the ones with whole and cut feathers were made. Its thermal properties were tested by exposing the wall models to a controlled environment with four lightbulbs surrounding it. The temperatures were obtained using the Extech HT30: Wet Bulb Globe Temperature (WBGT). The researchers used ANOVA to analyze the given data. Focusing on the main objective, the researchers analyzed the results from the cement blend type. Having the p-value of 0.15 be greater than alpha which is 0.05, the researchers have accepted its null hypothesis wherein the type of blend does not have an effect on the mean temperature difference between the side without the light bulb and the side with the light bulb. Nonetheless, based on the data gathered, the blend with 5% whole chicken feathers insulated the box well

1. Introduction
The temperature plays a role in the mortality of the public. Climate change could bring drought thus affecting the food and water supply [1]. The Philippines is one of the countries that experiences hot climates [2]. The Filipinos experience hot weather all their lives but this cannot make them immune to the negative effects of heat. Thus insulating the living environment could be a solution to combat the heat problem faced.

Insulating of houses will save energy and provide a healthier and more comfortable indoor environment [3]. Insulation of home means preserving the heat inside or keeping away the heat from the outside [3,4]. In countries that experience cold climates, they tend to install heaters in their homes.
Likewise, those countries with hot climates tend to put air conditioning in their homes [5]. This add-ons tend to be costly when used for a long period of time [5]. Insulating your home could save you energy as well as costs. Insulating not only saves you money but it also gives comfort in our everyday lives. Insulation can be applied on roofs, walls, and windows. Insulators come in sheets or foams or it could be a double glazed window [6]. Proper installation of insulators is also needed for it to be effective. One must make sure that the insulators are well fitted to ensure that no heat can escape or enter small gaps [7]. A study done in Australia by Aldawi et al. [8] saw that 40% of total household energy consumption constitutes to heating and cooling the residence and compared four different new walling systems to see which one can minimize the energy consumption.

The poultry industry in the Philippines is continuously growing. A lot of producers have penetrated the market. The commercial poultry sector is growing as well as the small scale sector [9]. The small scale sector is the called the Backyard Poultry Sector and it has less than 100 birds per unit [9]. Although each sector presents certain issues such as market instability, high input cost, low productivity, and inconsistent quality and supply, there is no sign of slowing down from the poultry industry. The growth of the poultry not only consist of the main chicken meat but also its feathers.

Study by Bansal [10] have proven that chicken feather fiber has properties that can be used in various applications. The keratin fibers from the chicken feathers present suitable characteristics that can be incorporated in polymer composites. These fibers are non-abrasive meaning that these fibers are non-irritating. The fiber is also biodegradable, renewable, eco-friendly, and insoluble in organic solvents. They also have low density, hydrophobic behavior, ability to dampen sound, and warmth retention. Chicken feather fiber was also used as a reinforcement to High Density Polyethylene Composites [11]. The properties of the chicken feathers were also tested when incorporated in polyester and phenyl ester [12]. Another composite material using chicken feathers is explored. In this study by Qin [13] the researcher only used the fibers of the feathers, he then incorporated it to polylactic acid (PLA). Chicken feathers are then added to cement to see if it’s viable for public consumption. The morphological characteristic of chicken feathers makes it a good candidate for thermal insulation [14]. It has been studied that chicken feathers can act as reinforcements to cement-bonded composites. In a study by Acda [15] the researchers made a panel out of chicken feathers, cement, sand, superplasticizer, calcium chloride, and water. A study has been made by Manginsay [16] to test the effect of chicken feathers as an additive in a concrete mixture.

Thus, in this study the researchers will focus on low budget insulators for the public. The researchers will use the chicken feather to insulate homes. The feathers will be infused in the mixture of cement, sand, and clay soil. The main aim of this study is to produce a cement mixture with feathers and clay soil that would effectively insulate a structure.

2. Methodology

2.1. Research Design

The study comprises of a cement compound infused with bird feathers and clay soil to act as the thermal insulation of the compound. In the design of this study, there are two setups that will be performed. One box will be filled with cement compound alone and another box will be filled with cement compound infused with bird feathers and clay soil. Comparison between the two setups will be studied if there will be any effect of the reinforcement agents added on the cement compound regarding their thermal insulating properties. The variables under study are those that may be a significant factor in the experiment. The variables are as follows: Cement Compound (CC), Cement Compound infused with Bird Feathers and Clay Soil (CCF), Whole Bird Feathers, Ground or Cut Bird Feathers, Partition wall, Dimensions of the box and Heat stress.
2.2. Subjects and Study Site
The study focuses on the thermal insulating properties of the bird feathers and clay soil. The cement mixture with whole bird feathers and clay soil, and another cement mixture with ground or cut bird feathers and clay soil are the subjects of the study. The bird feathers are known to have the capability to withstand temperature may it be hot and cold along with clay soil which are used for thermal insulation. The study will take place in the country of Philippines, National Capital Region. Experimental site will be in a controlled environment to maintain properly the data that will be gathered. A controlled environment is a setup where there will be an enclosed area to keep the temperature inside circulating and to have a standard basis of comparison with the temperature inside the separate boxes each filled with different cement mixtures.

2.3. Materials and setup
The experiment that will be conducted will have an aim on finding the temperature changes between different time intervals. The instrument that will be used is the Heat Stress Meter. The cement compound is made up of cement and fine sand with composition of 50:50. For the cement compound with chicken feathers and clay soil, chicken feathers and clay soil were added to the standard mixture with composition of cement 50%, fine sand 25% and chicken feather 5% of weight. The water composition for both mixture varies accordingly. The controlled set-up is a polystyrene foam board box with dimensions of 24 inches in length, 8 inches in width, and 10 inches in height. The bulb that was sourced as the heat of the experiment was a 100–watt incandescent bulb. The set-up was placed inside a room without air-conditioning units or electric fans used. The room is about 9 m² with concrete floor and wooden walls. The room temperature at the time of experiment was 73.5 °F. When the experimental setup was ready, the bulb with 100-wattage was turned on for 5 minutes. After the 5 minute heating, the bulb was turned off then initial readings for both sections of the box for a few seconds interval placing back the caps of the holes where the instrument was inserted to avoid escaping of air. When the first reading was recorded, another 5 minutes were added before taking the second reading. Second reading took place after 5 minutes. Cooling of the bulb was allowed for 10 minutes before preparing the next setup for another blend of compound mixture. Figure 1 shows the inside of the experimental setup box.

![Figure 1. Inside of the Experimental Box](image)

2.4. Mode of Data Analysis
In the process of data gathering, the analysis that will be used is ANOVA Two Factor with Replication. The aim in the use of this data analysis method is to know the significant effect of the
cement compound with bird feathers and clay soil in insulating a structure against the cement compound alone and its insulating property.

2.5. Hypothesis of the study

For blending, H0: The mean temperature differences of the side without the light bulb and the side with the light bulb separated by plywood and different cement blends are equal.

H1: The mean temperature differences of the side without the light bulb and the side with the light bulb separated by plywood and different cement blends are not equal.

For exposure duration, H0: The mean temperatures differences of the side without the light bulb and the side with the light bulb exposed to different durations of time are equal.

H1: The mean temperatures differences of the side without the light bulb and the side with the light bulb exposed to different durations of time are not equal.

For interaction, H0: The mean temperature difference using diff combinations of blends and exposure duration on the side without the light bulb and the side with the light bulb are equal.

H1: The mean temperature difference using diff combinations of blends and exposure duration on the side without the light bulb and the side with the light bulb are not equal.

3. Result and Discussion

Table 1 represents the actual temperature on the side of the experimental box with the light bulb and the actual temperature on the side of the experimental box without the light bulb. The test was done between plywood, whole feathers and blended feathers mixture. Based on Table 1, the result showed that blended feather mixture has the lowest temperature among the tested samples. For 5 minutes of light exposure, the blended feather mixture recorded temperature of 80.8 and 83.6 respectively and for 10 minutes exposure, temperature recorded was 83.4 and 85.6 (°F). Table 2 shows the result of temperature differences between the two tested sides. The blended feather sample showed the lowest temperature difference of 5.3 and 8.7 for 5 minutes light exposure, 6.9 and 9.8 for 10 minutes exposure. When the readings were analyzed using ANOVA Two Factor – With Replication, the results achieved were shown at Table 3. First factor tested was the cement compounds mixture. According to the results tested, it showed a p-value greater than the alpha level that concludes to accepting the null hypothesis which states that the mean temperature difference between the two sides of the experimental box is equal. It means that the type of blend does not have an effect on the mean temperature difference between the side without the light bulb and the side with the light bulb. Although the results turned out this way, we can still see that over time, the blend with the whole chicken feathers insulted the boxes better than the commercial mixture. Minor analyses were gotten from the statistics. Another factor that was analysed was the exposure duration. From the results, the researchers also accepted the null hypothesis. It means that the time duration wherein the cement blends were subjected to heat does not matter. The last analysis was the interaction between the type of blend and the exposure duration. The results also came to conclusion to accept the null hypothesis which is that the mean temperature difference using diff combinations of blends and exposure duration on the side without the light bulb and the side with the light bulb are equal. The relationship between the type of cement blend and the exposure duration does not contribute to the affectivity of the study.

| Table 1. Actual Temperature on the Experimental Box |
|-----------------------------------------------|
| Test samples | 5 Minutes | 10 Minutes |
| Side with Light Bulb (°F) | Side without Light Bulb (°F) | Side with Light Bulb (°F) | Side without Light Bulb (°F) | Side with Light Bulb Bulb (°F) | Side without Light Bulb Bulb (°F) |

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Table 2. Temperature Difference between the Two Side

| Test Sample   | 5 minutes (oF) | 10 minutes (oF) |
|---------------|----------------|-----------------|
| Plywood       | 10.5           | 8.5             |
| Whole Feather | 11.4           | 12.3            |
| Blended Feather | 5.3            | 6.9             |

Table 3. Summary Results of ANOVA

| Variable     | Mixture       | Exposure Duration | Interaction |
|--------------|---------------|-------------------|-------------|
| α            | 0.05          | 0.05              | 0.05        |
| C.R f        | 5.14          | 5.99              | 5.14        |
| Test stat f  | 2.66          | 0.92              | 0.6         |
| p-value      | 0.15          | 0.37              | 0.58        |
| Conclusion   | Accept H0     | Accept H0         | Accept H0   |

4. Conclusion

The key findings of this work can be concluded as follow. For blend, H0 was accepted. The cement blends with CFF did not affect the temperature inside the box. The CFF did not make much of a difference when it came to insulating the boxes. Nonetheless, based on the data gathered, the blend with whole chicken feathers insulated the box well. For exposure duration, The time duration wherein the cement blends were subjected to heat does not matter. As for interaction (Accept H0) the relationships between the blends and the exposure durations are insignificant since the means are equal.

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