Coir Dust as Sand-Substitute in the Manufacture of Concrete Hollow Blocks

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Abstract
Coconut is widely planted and produced in Region 8 that leads to the increasing volume of coir dust (CD) dumped as agricultural waste and perceived to be environmental and health hazard. These wastes can be utilized as sand-substitute in the making of concrete hollow blocks (CHB) on which compressive strength are tested in comparison to the actual CHB using the usual materials. Cement and water remained constant while three different ratios of sand-CD were used having three samples for each ratio. All samples once reached the proper curing period, were tested for its compressive strength, and it was found out that increasing fresh CD in CHB resulted to a decreasing compressive strength of CHB. Thus CHB with 25% CD can be utilized not as load bearing concrete hollow blocks but as partition blocks useful for environmental and technical purposes.

Keywords: environmental and health hazard; coco dust in CHB; compressive strength; partition blocks

Introduction
Coconut as the tree of life is one of the sources of raw materials in making new products such as ropes, bags, chairs and many more. Statistically, Region VIII ranked number three in the country in terms of area planted to coconut, and it has a total area of 636,325 hectares with around 72,358,765 trees in which 58,585,910 are bearing, and 13,772,910 are non-bearing, got fifteen percent of the total national area planted with coconut (Pilapil, n.d.). The data showed that this region has an abundant supply of coconut that helped the economy of the region grow and the whole nation as well.

Parallel to the aim of improving the country’s economy is the increasing amount of waste products that endanger not only the environment but also the living things especially man. One of the agricultural wastes that need to be taken notice by our government is coir dust. Coir fiber is extracted from the husk by mechanical methods. The husk contains 30 percent fiber and 70% coir dust (FIDA, n.d.). The more coconut trees produced and harvested the more coir dust (CD) dumped as agricultural wastes. According to the literature, coir dust is a health and fire hazard and could be a breeding ground for pests such as rhinoceros beetle, considered to be a destructive coconut pest (Medina et al., n.d.).

Coir dust that is organic in nature and is rich in lignin and tannin, is the by-product of husk processing. It appears fine and brown and absorbs more water than soil and decays slowly. Its maximum water holding capacity is reported to be 82.3 percent. Adding 2 percent of CD to the soil is claimed to increase the soil’s moisture holding capacity by 40 percent. CD is also rich in sodium and potassium salts (Villena et al., 1991).

The decomposition of CD is delayed if the said material is embedded in a mixture where oxygen is absent, which is true in concrete mixing. The presence of cement lessens the presence of air or voids thus limiting the oxygen exposure of coir dust.

To lessen if not totally eliminate the large volume of coir dust as agricultural waste, CD will be utilized as a substitute to sand in the making of concrete hollow blocks. The voluminous availability of coir dust in the country particularly in Region 8 can be supported as the Philippine Coconut Authority
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The study was conducted to determine the usage of coir dust CD in the making of concrete hollow blocks (CHB). Specifically, the study sought answers to the following questions:

1. What is the compressive strength of CHB with dried CD as substitute to sand in different ratios?

2. What is the compressive strength of CHB with fresh CD as substitute to sand in different ratios?

3. Are there significant differences between the compressive strength of CHB with dried and fresh CD as substitute to sand using varying ratios?

Materials and Methods

Research Design

In this study, the researcher used the experimental research method. The usual materials in making CHB such as cement, sand and water are used in the experiment with consideration of mixing it with varying amount of CD. Dried and fresh CD were both exposed to three varying ratios and processed separately. Each ratio had three samples that were all tested for compressive strengths using the Universal Testing Machine (UTM). The compressive strengths of the CHB with dried CD are compared with the compressive strengths of CHB with fresh CD.

Preparation of Experimental Materials

The materials and tools used in the making of CHB were portland cement, sand, water, coir dust, plastic gloves, CHB molders, palettes, plastic measuring containers, big scissors, working table, calibrated balance (sensitive to 0.01g), wooden compactor, shovel and 1 cu.ft. measuring container.

The source of CD was the coconut model farm of PCA in Sab-a Basin, Paglaum, Tacloban City. The researcher grouped the collected CD materials into two: one was left moist labeled as FRESH while the remaining CD was exposed under the sun for 6 to 8 hours to remove water content and labeled as DRIED.

To get the difference in weight of fresh and dried CD, 300-gram of fresh CD was set aside and weighed before exposing to the sun and weighed again after drying. Table 1 showed the result.

Both dried and fresh CD contained thin fibers and these were manually removed except for the shorter and thinner ones which were cut at a length of 2.54 cm.

Water from Leyte Metropolitan Water District (LMWD) was used to be sure that it is free from injurious amounts of oils, acids alkaline, salts, organic materials and other substances deleterious to concrete or reinforcement while sand was taken from Daguitan river with a maximum size of 5 mm.

Manufacturing Process

The experiment and actual process of manufacturing CHB was conducted at PCA, Candahug, Palo, Leyte. In measuring the materials, the researcher used the

<table>
<thead>
<tr>
<th>Weight of Fresh CD</th>
<th>Weight of Dried CD</th>
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<tbody>
<tr>
<td>300 g</td>
<td>176 g</td>
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</table>

Table 1: Difference in weight of fresh and dried coir dust.
volume-scheme following the ratio 1:5. For every bag of cement, a 5 cu.ft. (0.15 cu.m.) sand was used as a baseline in reducing the materials to test the size. Table 2 reflects the reduced amount of the materials enough to make just one (1) CHB.

The experiment involved both dried and fresh CD as substitute to sand using the test size. For each dried and fresh CD experiment, the three ratios are shown in Table 3. Table 3 shows varying ratios between sand and CD. Each ratio had three samples or replications to get accurate results of the compressive strengths.

The following symbols were used to designate the CHB treatments in varying ratios:

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Cement</th>
<th>Sand</th>
<th>Coir Dust (CD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0</td>
<td>100%</td>
<td>100%</td>
<td>0</td>
</tr>
<tr>
<td>D25</td>
<td>100%</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>D50</td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Cement, sand and CD were measured carefully before mixing. Throughout the experiment, cement and water remained constant while sand and CD were measured using the following ratios: a) 0.0075 cu.m. sand : 0 CD, b) 0.0056 cu.m. sand : 0.0019 cu.m. CD, c) 0.0038 cu.m. sand : 0.0038 cu.m. CD.

First, the sand and cement were mixed using a shovel. Then coir dust was added. After thorough mixing with water, the matrix was placed in individual, tamped, leveled, removed from molders and allowed to dry naturally. Undisturbed samples were placed vertically in a cold and covered place to avoid fast dehydration. Curing the matrix was allowed for a minimum of 28 days, and sprinkling of water to the finished products especially during days was done as needed.

### Compressive Strength Test

The laboratory test for compressive strength of the CHB samples was conducted using the Universal Testing Machine (UTM) at the Material Testing Laboratory (MTL) of Eastern Visayas State University (EVSU), Tacloban City. Each of the CHB sample was placed on the UTM and load was applied continuously with increasing value until the CHB gave way or broke. The readings on the machine were recorded properly.

### Statistical Analysis

The compressive results of the CHB using different ratios were tallied, compared and subjected to analysis of variance (ANOVA), 2 x 3 factorial design to determine if there is significant difference between the use of dried and fresh coir dust in the making of CHB at 0.05 level of significance.
Results and Discussion

Using the by-volume basis of measuring the different ratio and after careful testing of the compressive strength of the CHB samples using the UTM at EVSU-MTL, the following were the findings:

The compressive strength of the three samples using the different ratio of dried CD as substitute to sand experienced a diminishing trend. The resulting compressive strength values were 281,395 kg/m², 57,366 kg/m², and 46,611 kg/m² for D₀, D₂₅, and D₅₀ samples respectively.

The CHB samples with fresh CD also experienced a diminishing trend of compressive strength values such as 281,395 kg/m², 57,336 kg/m², and 46,510 kg/m² for F₀, F₂₅, and F₅₀ samples respectively.

Comparison of the Compressive Strength of CHB

The F-value for the comparison between the compressive strength of the CHB with dried CD against the fresh CD was 14.108 that was significant at 0.05 level.

The computed F-value for the different mixtures tested for difference in compressive strength is 153,948.73 which was significant at 0.05 level.

Results show that the F-value for the interaction between the CD type and the CD proportion on the compressive strength of CHB mixtures was 14.1 and was significant at 0.05 level.

Conclusion

The following conclusions are drawn based on the results obtained from the research:

1. The trend of increasing CD content in CHB resulted to a decrease in compressive strength of CHB. The CD content in CHB and the compressive strength of the CHB revealed an inversely proportional relationship thus the more CD content in CHB, the weaker the CHB.

2. There is a significant difference between the compressive strength of CHB using varying ratios of dried and fresh CD as substitute to sand.

Recommendations

The following recommendations are hereby formulated:

1. Since the presence of CD in the CHB reduced the compressive strength of CHB, it is not advisable to use the CHB with CD as load-bearing concrete hollow block but just as partition blocks.

2. To utilize CD in CHB for environmental purposes, utilize the 75% sand - 25% CD ratio as partition blocks not as load-bearing blocks.

3. There is a need to conduct a study on the water absorption, fire resistance and thermal expansion properties of CHB with 25 percent CD in CHB.

References


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