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RESEARCH ARTICLE

A COMPARATIVE STUDY OF THE COMPRESSIVE STRENGTH OF CONCRETE HOLLOW BLOCKS USING RIVER AND SEA SANDS

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ABSTRACT

This study was conducted at Engineering Laboratory Building of ESSU-Salcedo Campus, Salcedo, Eastern Samar. Specifically, this study was concerned with the following objectives: (1) To determine the weight of the Concrete Hollow Block (CHB) using river and sea sands, (2) To determine the compressive strength of CHB using river and sea sands, and (3) To determine the significant difference between the compressive strength of CHB using river and sea sands with a varying amount of fine aggregates of 100%, 50%, and 33.33%. The amount of fine aggregate varies in each level of treatment considering the workability of the mixture. Seven (7) levels of treatments were replicated five (5) time. Weighing and Compressive Testing was carried out using thirty-five (35) pieces whole concrete hollow block samples. Result of the study revealed that the initial weight was 10,790 grams and a maximum of 11,645 grams. The initial crushing strength gained 2.4 MPa (384.11 psi) and a maximum of 4.7 MPa (681.71 psi). Thirty four (34) CHBs surpassed the standard individual compressive strength of 350 psi and all treatments surpassed the standard average compressive strength of 300 psi. The compressive values obtained from the specimens were above the standard. It was found out that treatment two (T_2) gained the highest compressive strength of 4.20 MPa (609.20 psi) contained with white sea sand inert material.

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INTRODUCTION

Concrete Hollow Block (CHB) is a compressed mixture of screened sand and cement. Blocks are classified as bearing and non-bearing. Load bearing blocks are those whose thickness ranges from 15 cm to 20 cm and are used to carry loads aside from their own weight. Non-bearing blocks on the other hand are intended for walls, partitions, fences, or dividers carrying their own weight whose thickness ranges from 7.5 cm to 10 cm. The common and ordinary type of CHB are those with three whole cells vary in sizes as there are different manufacturers using different moulds (Fajardo, 2000). Concrete mixtures provide a wide range of mechanical and durability properties to meet the design of a structure. Compressive strength is the most performance measure used by engineers in designing building and other structures. It is measured by breaking cylinders specimens in a compression testing machine. Compressive strength is determined to meet the requirements of the specified strength in the job specification.

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The specified strength is incorporated in the job documents (NRMCA, 2003). Eastern Samar has an abundance source of river and sea sands to be utilized in manufacturing of CHB. Balangiga, Guiuan and Llorente had a leading supply of river sand, white sea sand, and gray sea sand, respectively. There are some CHB manufacturers of these municipalities that had been using the sand availbale in their respective places. Manufactured CHB are purchased by some contractors and builders from different areas. Many contractors and builders uses CHB made from river and sea sands in residential, industrial building, and other concrete structures.

Objectives of the Study

This study aimed to evaluate the weight and compressive strength of CHB using river and sea sands in Balangiga, Guiuan and Llorente, Eastern Samar. It answered the following objetives:

- To determine the weight of the CHB using river and sea sands.
- To determine the compressive strength of CHB using reiver and sea sands.

- To determine the significant difference in the compressive strength of CHB using river and sea sands.

Review of Related Literature and Studies

Compressive Strength Tests of Concrete Hollow Block: Based on the Philippine Trade Standard Specification for Concrete Hollow Blocks as cited by Amistad (2008), the following are the procedures in conducting compressive strength test of concrete hollow block. Measure the dimension of each unit, then cap the bearing surface with gypsum plaster to filter to a thickness of not more than 3 mm (1/8 inch). Allow the cap to solidify for a minimum of 2 hours before testing. Set the specimen concrete hollow block. The upper bearing should be firmly attached at the center of the sensitive platen of the universal testing machine. Apply the load at a uniform rate until failure occurs. Record the maximum load by the gross cross-sectional area of the unit in square centimeters. The gross area of the unit is the total area of the section perpendicular to the direction of the load including the areas within the cells, and re-entrant spaces.

Comparison of Sea sand and River sand: Chandrakeerthy (1994) mentioned that aggregate which consist of sizes below 5 mm and above 150 mm is an important constituent of concrete because it occupies above 25 to 30 percent of local concrete. It affects the properties of hardened concrete such as durability, strength, thermal and friction properties, unit weight and economy. The advantage of sea sand are: grading is generally good; it contains no organic contamination, silt or weak small gravel particles; and chloride content can be reduced by washing with even sea water. The disadvantages are: it may lead to corrosion of reinforcement; demand for water and cement is high; usually used after washing to remove salt contamination; shell content affect strength, weight, permeability and workability of concrete. On the other hand, river sand is the most widely used fine aggregate. It contains no chloride, it requires less water and cement to attain good workability. The disadvantages are: may contain organic contamination as well as some silt; may contain small gravels which are weak. Silt, clay and dust affects bond, strength and water requirement.

Studies on the Compressive Strength of Concrete: In the study on the "Effect of Aggregate Types on Compressive Strength of Concrete" demonstrated that the three types of coarse aggregates: quartzite, granite and river gravel were significantly different in terms of workability and compressive strength. Test result showed that that concrete made from river gravel has the highest workability, followed by crushed quartzite and crushed granite aggregates. Highest compressive strength at all ages was noted with concrete made from quartzite aggregate followed by river gravel and then granite aggregate. Compressive strength models were proposed as a function of age at curing. Hence, aggregate made from quartzite is advisable to be used for concrete work (Abdullahi, 2012).

MATERIALS AND METHODS

Research Design: A Complete Randomized Design (CRD) with seven (7) treatments and five (5) replications was used in the study. The stretcher type of CHB with three (3) cores was the model of this study. It has a dimension of four (4) inches thick, eight (8) inches height, and 16 inches length (4" x 8" x 16'). The following treatments were tested in this experiment:

$T_{1=}$40 kg Portland cement + 0.068 m^3 river sand + 0.102 m^3 stone chips + 20 liters of water
$T_{2=}$40 kg Portland cement + 0.068 m^3 white sea sand + 0.102 m^3 stone chips + 20 liters of water
$T_{3=}$40 kg Portland cement + 0.068 m^3 gray sea sand + 0.102 m^3 stone chips + 20 liters of water
$T_{4=}$40 kg Portland cement + 0.034 m^3 river sand and 0.034 m^3 white sea sand + 0.102 m^3 stone chips + 20 liters of water
$T_{5=}$40 kg Portland cement + 0.034 m^3 river sand and 0.034 m^3 gray sea sand + 0.102 m^3 stone chips + 20 liters of water
$T_{6=}$40 kg Portland cement + 0.034 m^3 white sea sand and 0.034 m^3 gray sea sand + 0.102 m^3 stone chips + 20 liters of water
$T_{7=}$40 kg Portland cement + 0.023 m^3 river sand, 0.023 m^3 white sea sand and 0.023 m^3 gray sea sand + 0.102 m^3 stone chips + 20 liters of water

Materials

The materials were sourced from reputable suppliers of aggregates in Eastern Samar. Five (5) cubic feet of river sand was taken from L.M. Pabello Gravel and Sand in Balangiga, Eastern Samar. One-half cubic meter of white sea sand was obtained from Guiuan Electrosteel Enterprises. One-half cubic feet of Stone chips and one-half cubic feet of gray sea sand were purchased in Sand & Gravel and Concrete Products in Llorente, Eastern Samar. Manufacturing of CHB was done at Engineering Laboratory Building, ESSU-Salcedo Campus, Salcedo, Eastern Samar.

Manufacturing of CHB

Following the procedure provided by Niňo and Niňo (1989), the sieved sand and coarse aggregates were measured using a measuring box of 30 x 30 x 30 cm. The amount of cement needed was weighed using a digital weighing scale. The proportioned cement and aggregate were mixed or inverted four (4) times until a uniform color was obtained. Exact amount of water was added to make it workable, mixed it for three (3) minutes until desired plasticity was achieved. The CHB moulder was filled fully with the mixture, vibrated once until the mixture settled down and compacted using a wooden flail. The samples were air dried for fifteen (15) days. These were laid down over the round poles to prevent surface water absorption. Curing was done for 84 days by sprinkling 3 liters of clean water for every treatment.

Description of CHB Samples for Analysis: The width of the top cavity was 2 inches then the length was 3 10/16. The bottom cavity was 1 and 12/16 inches width and 3 5/16 length. The two side cavities were 9/16 inches in length at the top, 7/16 inches at the bottom. The height of the block was 8 inches and its length was 16 inches. The solid volume of the sample per unit was 338.9619 cubic inches equivalent to 0.1962 cubic feet or 66%.

Weighing and Compressive Strength Test: Five (5) CHB was used for each of the seven (7) treatments to determine the compressive strength. Weighing was done using tri-beam balance before compression testing. The determination of crushing strength was made by applying a load to the bedding surface of the block using digital compression testing machine owed by MCAP. The maximum crushing strength values were determined by the initial crack occurrence. Data gathered were analyzed using Mean and Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Mean Weight of CHB. Table 1 shows the mean weight in grams of the Concrete Hollow Blocks (CHBs) as affected by the different types of sand. The total mean weight of the specimens was 11, 213.91 grams. The analysis of variance as shown in table 2a indicates that significant difference occurred among the seven treatments. The computed F-value was 2.545 with a p-value of 0.043 which means that the weight of CHB was affected due to a combination of different types of sand used. Using LSD at 0.05 level of significance, treatment 7 shows that combining river sand, white and gray sea sand produce a light weigh CHB and is comparable to treatment 2 and 6.

Table 1. Mean Weight (g) of CHB as Affected by the Different Types of Sand

Treatments	Number of Samples	Mean Weight (g)
1	5	11,363.20[a]
2	5	11,126.40[ab]
3	5	11,271.40[a]
4	5	11,226.80[a]
5	5	11,385.00[a]
6	5	11,196.40[ab]
7	5	10,928.20[b]
Grand Mean		11,213.91

Treatment means followed by common letter are not significant different using LSD=0.05

Table 1a. Analysis of Variance on the Mean Weight (g) of CHB as Affected by the Different Types of Sand

Sources of Variations	Degrees of Freedom	Sum of Squares	Mean Squares	F-value	p-value	Description
Treatments	6	723,126.74	120,521.21	2.545	0.043	Significant
Error	28	1,326,718.00	47,347.07			
Total	34	2,046,844.74				

Table 2. Compressive Strength (MPa) of CHB as Affected by the Different Types of Sand

Treatments	Number of Samples	Mean Compressive Strength (MPa)
1	5	2.78[b]
2	5	4.20[a]
3	5	2.98[b]
4	5	3.56[a]
5	5	3.30[b]
6	5	3.22[b]
7	5	2.96[b]
Grand Mean		3.29

Treatment means followed by common letter are not significant different using LSD=0.05

Table 2a. Analysis of Variance on the Compressive Strength (MPa) of CHB as Affected by the Different Types of Sand

Sources of Variations	Degrees of Freedom	Sum of Squares	Mean Squares	F-value	p-value	Description
Treatments	6	6.855	1.142	6.263	0.000	Highly Significant
Error	28	5.108	0.182			
Total	34	11.963				

Compressive Strength of CHB

Table 2 shows the compressive strength of CHB as affected by the different types of sand. It was observed that treatment 2 which was the white sea sand got the highest mean socre of 4.20 Mega Pascal (MPa) while treatment 1 which utilized river sand obtained the lowest mean value of 2.78 MPa. The analysis of variance as shown in table 2a indicates that significant difference of compressive strength existed among the seven treatments. The computed F value of 6.263 with a p-value of 0.000 leads to the rejection of the null hypothesis which means that the compressive strength of CHB was affected due to the type of sand used. Further test using LSD at 0.05 level of significance showed that the use of white sea sand tend to produce the best quality of CHB. Such value is comparable to treatment 4 which utilized equal amount of white sea sand and river sand. This means that hollow block makers may combine river sand and white sea sand, yet, the same quality was produced to that of 100% white sea sand. On the other hand, combining white sea sand and gray sea sand (treatment 6) was just comparable to combining river sand and gray sea sand (treatment 5), gray sea sand along (treatment 3), river sand alone (treatment 1) and even using equal amount of river sand, white sea sand and gray sea sand (treatment 7). It can be implied from this study that if white sea sand is available in the locality, it can be used as inert materials in manufacturing CHBs, but it should be washed before using it, to lessen or remove salt contaminants.

Conclusions and Recommendations

Based on the study conducted, the following conclusions were drawn: From the seven treatments tested, it can be deduced that treatment 7 which combined 0.023 m^3 river sand, 0.023 m^3 white sea sand and 0.023 m^3 gray sea sand produced the lightest weight of Concrete Hollow Blocks (CHB). Such aggregate combination is comparable to treatment 2 with 0.068 m^3 white sea sand and treatment 6 with aggregate combination of 0.034 m^3 white sea sand and 0.034 m^3 gray sea sand. On the other hand, it is safe to say that treatment 2 with 0.068 m^3 white sea sand has the highest compressive strength which is comparable to treatment 4 which combined 0.034 m^3 river sand and 0.034 m^3 white sea sand. It is therefore recommended that in order to produce best quality CHB white sea sand should be used.

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