Utilization of Crushed "Leddeg" (Freshwater snail) Shells as a partial cement replacement in Concrete Hollow Blocks Production

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ABSTRACT

Waste material such as crushed Leddeg (freshwater snails) shells is investigated in this study to partially replace cement in CHB mixtures. The primary objective of this research is to assess the influence of 0%, 5%, 10%, and 15% replacement levels on the compressive strength and water absorptive capacity of the CHBs after 7, 14, and 28 days of curing, as well as to establish the methods of preparation and application of the crushed Leddeg shells in CHB formulation. A quantitative-experimental research design was adopted in this study. Twelve CHB samples were tested under laboratory conditions. Descriptive statistics and trend analysis were used for analyzing the test results. The findings have shown that as the percentage of the crushed Leddeg shells increases, there is also an increase in the compressive strength of CHBs. The compressive strength was peak at 28 days, with the 15%, 10%, and 5% replacement mixes showing compressive strengths of 6.70 MPa, 4.95 MPa, and 4.88 MPa, respectively, compared to the control mix which only showed a compressive strength of 4.10 MPa. Similarly, the absorption capacity of the CHB mixtures was reduced with as the percentage of crushed Leddeg shells replacement increased. The findings indicate that the crushed Leddeg shells with high calcium carbonate content helped increase the packing efficiency of the materials used in the CHBs, which resulted in better physical and mechanical properties of CHBs. It is concluded from the experiment that crushed Leddeg shells can be used as supplementary cementitious material in non-load-bearing concrete hollow blocks. The use of 15% replacement of crushed Leddeg shells showed the best performance.

Keywords: – Crushed Leddeg (Freshwater snail shells), Compressive Strength, Water Absorption Capacity, partial cement replacement, curing

INTRODUCTION

With the rise in the demand for cement and concrete hollow blocks (CHBs), there has been increased use of Ordinary Portland Cement (OPC), the production of which is known to be one of the main sources of carbon dioxide emissions. To deal with this situation, studies have been conducted on different supplementary cementitious materials obtained from waste materials that can help reduce the use of cement without affecting the engineering characteristics of concrete products. Some of these supplementary cementitious materials include calcium carbonate-containing shells, which have been studied for their ability to partially replace OPC due to their filling characteristics and improved performance of cementitious composites. Nonetheless, most studies have been limited to marine shells and agricultural waste products, whereas crushed Leddeg (freshwater snails) shells remain largely underexplored despite their availability and high calcium carbonate content.

The use of crushed Leddeg shells in CHBs can prove to be a good environmental approach in the management of shell waste, as well as the reduction of cement usage in CHBs. It is important to establish the engineering properties of CHBs made from crushed Leddeg shells in order to find out whether there will be any impact on the quality of the final product. In this regard, this research study aims at assessing the impacts of using 0%, 5%, 10%, and 15% crushed Leddeg shells partially replacing cement, on the compressive strength and water absorption capacity of concrete hollow blocks after 7, 14, and 28 days of curing.

METHODOLOGY

A quantitative experimental design was used in this study to examine the possibility of incorporating the use of crushed Leddeg (freshwater snail) shells as a partial replacement of cement in the production of concrete hollow block (CHB). Four mixture ratios involving 0% (control), 5%, 10%, and 15% replacement levels of crushed Leddeg shells in terms of weight of cement were used. The CHBs were produced through 1:7 ratio of cement-to-sand at a water-cement ratio of 0.50 and formed in 150mm x 200mm x 400mm CHB molds. The Leddeg shells were obtained from Aloragat River, Barangay Cabanbanan, Manaoag, Pangasinan; washed clean and then exposed to sun drying for five days, before being crushed and pulverized to form fine powder to be used in the mixing process. A total of twelve (12) specimens were made.

Table 1 Mixture Proportions in the Production of CHB without/with Crushed Leddeg Shells (CLS)

Mixture level	Cement Replacement Level	Cement:Sand Ratio	Water-Cement Ratio
Control	0%	1:7	0.50
5% CLS replacement	5%	1:7	0.50
10% CLS replacement	10%	1:7	0.50
15% CLS replacement	15%	1:7	0.50

Table 2 Materials Used in the Production of CHB without/with Crushed Leddeg Shells (CLS)

Mixture level	Water	Cement	Sand	CLS
Control	0.51 kg	1.02 kg	7.90 kg	0
5% CLS replacement	0.51 kg	0.969 kg	7.90 kg	0.051 kg
10% CLS replacement	0.51 kg	0.918 kg	7.90 kg	0.102 kg
15% CLS replacement	0.51 kg	0.867 kg	7.90 kg	0.153 kg

The quantities were calculated based on a per CHB production.

RESULTS AND DISCUSSION

Table 3 Compressive Strength of CHB without/with Crushed Leddeg Shells (CLS

Replacement Level of CLS	7 Days (Mpa)	14 Days (Mpa)	28 Days (Mpa)
0%	0.43	0.69	4.10
5%	0.84	0.93	4.88
10%	1.20	2.51	4.95
15%	2.31	5.39	6.70

From the experimental findings, it is evident that increase in the percentage of the crushed Leddeg shell in the CHB resulted in improved engineering properties. This was seen through increase in the compressive strength of the concrete mix with increase in curing time, reflecting the progress in hydration of the cement. All the four different mixtures had their compressive strengths improve with increased curing time. The mixture with 15% of crushed Leddeg shell had the highest compressive strength of 2.31 MPa, 5.39 MPa, and 6.70 MPa for 7 days, 14 days, and 28 days of curing respectively. The mixtures of 10% and 5% showed better compressive strengths compared to the control mixture with compressive strengths of 4.95 MPa and 4.88 MPa after 28 days of curing respectively. On the other hand, the control mixture had a compressive strength of 4.10 MPa after 28 days of curing. This shows that the use of crushed Leddeg shell resulted in improvement in the compressive strength of the CHB and the 15% replacement level performed best, due to high levels of calcium carbonate in the shells.

Table 4 Water Absorption Capacity of CHB of CHB without/with Crushed Leddeg Shells (CLS

Replacement Level	7 Days kg/m³ (%)	14 Days kg/m³ (%)	28 Days kg/m³ (%)
0%	833.62 (20.61)	521.38 (18.14)	594.10 (25.74)
5%	645.36 (21.60)	468.00 (19.09)	392.06 (26.49)
10%	639.65 (19.49)	485.86 (17.05)	433.97 (24.73)
15%	625.61 (18.26)	421.86 (15.95)	359.81 (20.45)

The findings of water absorption test indicated that addition of crushed Leddeg shells significantly lowered the water absorption ability of the CHBs. After seven days, the 15% replacement sample demonstrated the least water absorption of 625.61 kg/m³ (18.26%), followed by the 10% and 5% samples respectively, whereas the control (0%) showed the maximum value of 833.62 kg/m³ (20.61%). A comparable trend was noticed after 14 days, where the 15% replacement demonstrated the least water absorption of 421.86 kg/m³ (15.95%), compared to 468.00 kg/m³ (19.09%) of 5%, 485.86 kg/m³ (17.05%) of 10% and 521.38 kg/m³ (18.14%) of the control sample. After 28 days of curing, the 15% replacement again demonstrated the least water absorption of 359.81 kg/m³ (20.45%), followed by 5% sample at 392.06 kg/m³ (26.49%), 10% sample at 433.97 kg/m³ (24.73%), and control sample at 594.10 kg/m³ (25.74%). Thus, it can be seen that increase in the percentage of crushed Leddeg shells also increased the CHBs' water absorption capacity, with the 15% replacement showing the best results. The observed reduction in water absorption may be attributed to the fine grinding of calcium carbonate rich Leddeg shells, which increased the density of the concrete matrix.

CONCLUSIONS/RECOMMENDATIONS

The findings of this research revealed that crushed shells of Leddeg (freshwater snail) can be used as partial substitute for cement in the production of non-load-bearing CHB. As the percent of crushed Leddeg shell increased in the mixture, there was an increase in the compressive strength and decrease in the water absorption capacity of the CHB. CHB mixtures with 15% crushed Leddeg shell gave the highest compressive strength and lowest water absorption rate after 28 days of curing period. It therefore implies that crushed Leddeg shells have the ability to be used as a sustainable supplement for cement in the production Concrete Hollow Blocks.

From the results obtained, it is recommended that the usage of 15% crushed Leddeg shell as cement replacement material may be used to produce non-load-bearing CHB. Future studies should have replications of the specimens for every treatment so that the reliability of the data can be improved and interaction effects can be analyzed. Additional studies may be done to test higher proportions of the cement replacement material, long-term effects of the crushed Leddeg shells, and its structural and chemical properties.

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