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Compressive strength of concrete hollow blocks with upcycled plastics as partial replacement for choker aggregates

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Abstract

This study was conducted to test the compressive strength of concrete hollow blocks prepared from three treatments with upcycled plastics as partial replacement to choker aggregates, find out which proportion of concrete hollow blocks with upcycled plastics was the most acceptable in terms of compressive strength, and ascertain the cost analysis of concrete hollow blocks. The study used Randomized Complete Block Design (RCBD) replicated three times composed of the three proportions with upcycled plastics and the control group cured in 28 days. The Universal Testing Machine (UTM) was used to test the compressive strength. Results of the study showed that the control group had a highest compressive strength. Treatments B and C had equal compressive strength. Treatment C had the lowest compressive strength of 2.00 MPa. The results of all treatments passed the minimum compressive strength of 1.50 MPa. In addition, the masses of the concrete hollow blocks in all treatments, including the control group were lightweight. As to cost, results indicated that the concrete hollow blocks prepared from 0% upcycled plastics obtained the lowest price in terms of cost analysis. With these results, the use of concrete blocks using upcycled plastics as construction materials in projects is highly forwarded. Concrete and manufacturing industries may also venture into the production of concrete blocks using upcycled plastics to encourage backyard economy, recycle wastes, and help in the conservation of the environment.

Keywords: *concrete hollow blocks, compressive strength, upcycled plastics, choker aggregates, cost analysis*

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Introduction

Plastic waste is increasing day by day throughout the world much more in the Philippines. The National Solid Waste Management Commission (NSWMC) reported that there is a total of 30,000 tons per day of solid waste in the Philippines. In addition, plastics account for 17% of total solid waste generated in the country. In the world famous Boracay Island in Western Visayas alone, the Department of Environment and Natural Resources has reported that there are 100 tons of trash, including plastic waste, generated daily that are hauled to mainland Aklan for disposal. With the bulk of garbage collected, sooner or later, this would become a problem unless a solution is put forward (Teves, 2018).

In this regard, the Philippine government has pushed forward the recycling of wastes that include plastics. As the quantity of waste generated increases yearly, recycling these wastes can minimize the bulk and burden of plastic waste. Recycling plastic has advantages since it is widely used worldwide and has a long service in life where plastic wastes are collected and removed from the waste stream. However, only 8.4% of plastic waste is recycled in the Philippines (Madlangbayan et al., 2017). The Bulacan-based company, The Green Antz Builders, Inc., has experimented on manufacturing concrete bricks added with plastic waste in their infrastructure construction (Galang, 2015). Although a number of studies has shown that concrete blocks added with plastic waste additives decrease their strength (Lejano et al., 2019), the combination of plastic waste aggregates with other waste materials as mussel shell and fly ash has increased their compressive strength (De Jesus et al., 2017; Madlangbayan et al., 2017; Shoubi et al., 2013; Wonderlich, 2014).

It is on this context that this study was undertaken to find out the possibility of using upcycled plastics as replacement for choker aggregates in the manufacture of concrete hollow blocks (CHB). It would specifically test the compressive strength of the CHB mixed with upcycled plastics as partial replacement of choker aggregates in different proportions.

The results of this experimental study would benefit particularly the end users or consumers who can find in the market a replacement or an alternative to the high cost of commonly sold concrete hollow blocks made from sand and cement. This would also be beneficial to the hollow block fabricators and manufacturers as the material cost as well as the return of investment may be more efficient than the popularly marketed product. More

importantly, the use of upcycled plastics as substitute to choker aggregates would lessen the bulk of plastic wastes affecting the environment.

Methodology

This experimental research utilized the Randomized Complete Block Design (RCBD) where investigation specifies a control group and an experimental group. This method involves control, randomization, and manipulation (Kabir, 2018), tests hypothesis concerning cause and effect relationship, and represents the most valid approach to the solution of problems (Gay & Airasian, 2003, in Binag, 2016). The RCBD is a design in which the experimental material is divided into blocks/groups of homogeneous experimental units, and each block/group contains a complete set of treatments which are assigned at random to the experimental units (Ullah, 2019).

The study was conducted at a hollow block fabrication site, and the finished concrete hollow blocks (CHB) were tested at a concrete and material testing laboratory. Field notes were used throughout the study to record all the materials, tools, equipment, and procedures utilized including his observation from Day 1 of the experiment up until the testing of concrete hollow blocks at the experimental site.

Standard size concrete hollow blocks were utilized as test specimens whose mixture was composed of cement, fine sand, choker aggregates, water, and upcycled plastics cured for 28 days. Upcycled plastics replaced a certain volume of choker aggregates by weight at different levels of percentage with a constant volume of cement and water ratio.

The study adopted the standard concrete masonry unit dimensions set by the National Building Code of the Philippines and National Structural Code of the Philippines for non-load-bearing walls with dimensions of 4” x 8” x 16”. The treatments were: Control – 0% upcycled plastics and 100% choker aggregates; Treatment A – 1% upcycled plastics and 99% choker aggregates; Treatment B – 2% upcycled plastics and 98% choker aggregates; and Treatment C – 3% upcycled plastics and 97% choker aggregates. Data were gathered in three ways: (1) pre-experimental stage, (2) experimental stage, and (3) post-experimental stage. The analysis of the CHB compressive strength used the Jamovi Statistical Software while percentage, mean, and standard deviation were used to analyze the descriptive data. Kruskal Wallis was used to determine the significant difference of compressive strength with the level of significance for the acceptability of the null hypothesis is 0.05.

All ethical issues related to study were addressed and secured, including health protocols.

Findings

Results of the experiments showed that the mass of the control group composed of 80kg choker aggregates, 9L water, 20kg cement and 40kg fine sand has the highest mean of 11.36 kilograms while Treatment C composed of 77.6kg choker aggregates, 9L water, 20kg cement, 40kg of fine sand and 2.4kg of upcycled plastics had the lowest mass of 10.49 kilograms. Moreover, Treatments A and B had almost the same mean mass of 11.04 and 11.06 kilograms, respectively. The mass of the all treatments was categorized as lightweight.

The compressive strength of the control group had the highest mean of 4.67 MPa while Treatment C had the lowest compressive strength with a mean of 2.00MPa. In addition, Treatments A and B had the same compressive strength of 2.67 MPa.

There is no significant difference in compressive strength in three proportions of concrete hollow blocks with upcycled plastics since the p-value is 0.062.

The most acceptable proportion of concrete hollow blocks with upcycled plastics was the control group having the highest compressive strength of 4.67 MPa where the minimum compressive strength for non-load bearing concrete hollow blocks was 1.50 MPa.

As to cost analysis, findings revealed that the concrete hollow blocks prepared without upcycled plastics had the cheapest price of Php12.22 while Treatment C had the most expensive price of Php17.88 per piece.

Conclusion

Based on the findings, it can be deduced that the different proportion of concrete hollow blocks on the composition of materials in the fabrication of concrete hollow blocks resulted to varying mean scores but had not affected the mass.

Generally, the concrete hollow blocks with upcycled plastics in all treatments including control group passed the minimum compressive strength of 1.50 MPa. This indicated that the concrete hollow blocks replacing choker aggregates at 1-3% by weight can be used in the construction as a non-load-bearing concrete hollow block. Although statistical test showed that the compressive strength of concrete hollow blocks was not significant, the

increase in compressive strength is a testament that the partial replacement of upcycled plastics for choker aggregates from 1% to 3% by weight is not detrimental to the strength properties of concrete.

As to the Return of Working Capital (ROWC), it can be concluded that the more the upcycled plastics is incorporated in concrete hollow blocks, the higher the ROWC. This implies that the higher the return, the more expensive the price of concrete hollow blocks per piece becomes.

Thus, concrete and manufacturing industries may consider the use of concrete blocks using upcycled plastics as part of construction materials in projects as the compressive strength and price are comparable with the commercial hollow blocks. They may also venture into the production of said concrete blocks using upcycled plastics to encourage backyard economy, recycle wastes, and help in the conservation of the environment.

References

Bhandar, P. (2021). A guide to ethical considerations in research. https://www.scribbr.com/methodology/research-ethics/

Binag, N. (2016). Powdered shell wastes as partial substitute for masonry cement mortar in binder, tiles and bricks production. *International Journal of Engineering Research and Technology (IJERT)*, 5 (7), 2278-0181

Cabahug, R., Bacol, J., Lagutin, P. G., Luniza, L. J., Mamon, G. C., & Pilapil, P. N. E. (2016). Crumb rubber tire as a partial replacement for fine aggregates in concrete hollow blocks. *Mindanao Journal of Science and Technology*, 14, 18-24.

Cabarle, K. (2023). Concrete hollow blocks (CHB) guaranteed best construction material *Philippines' Prices*. https://constructph.com/concrete-hollow-blocks-chb-construction-material-philippines-prices/

De Jesus, R., Pelaez, E. B. & Cañeca, M. C. (2017). Experimental study on the mechanical behavior of concrete beams with shredded plastics. *International Journal of Geomate*, 14 (42), 71-75.

Department of Public Works and Highways (DPWH), Memorandum Order 230, Series of 2016, III, 1-6. https://www.dpwh.gov.ph/dpwh/sites/default/files/issuances/DO_230_s2016.pdf

Dutta, S., Nadaf, M. B. & Mandal, J. N. (2016). An overview of the use of waste plastic bottles and fly ash in civil engineering applications. *Procedia Environmental Sciences*, 35, 681-691.

Guial, T.A & Jalbay, D.A. (2017). A comparative study of the compressive strength of concrete hollow blocks using river and sea sands. *International Journal Current Research*, 9(5), 50906-50909.

Galang, (2018). How to solve the waste plastic problem one eco brick at a time? The Business World. https://www.bworldonline.com/editorspicks/2018/11/06/197272/how-to-solve-the-waste-plastic-problem-one-ecobrick-at-a-time/

Jibrael, M., & Peter, F. (2016). Strength and behavior of concrete contain waste plastic. *Journal of Ecosystem and Ecography*, 6(2), 1-4.

Kabir, S.M.B. (2018). *Research Design*. www.researchgate. net/publication.

Lejano, B., Ang, R. J. & Dagdagan, V. J. (2019). *Partial cement replacement with fly ash and powdered green mussel shells for masonry blocks with plastic waste aggregates*. DLSU Research Congress: Knowledge Building Towards Industry 4.0.

Madlangbayan, M., Lasco, J.D., & Sundo, M. (2017). Compressive strength and bulk density of concrete hollow blocks (CHB) with polypropylene (PP) pellet as a partial replacement for sand. *Civil Engineering Journal*, 3(10), 821-830.

Muyen, Z., Barna, T. N., & Hoque, M. N. (2016). Strength properties of plastic bottle bricks and their sustainability as construction materials in Bangladesh. *Progressive Agriculture*, 27 (3), 362-368.

Peng, B., & Yu, W. (2018). A micromechanics theory for homogenization and dehomogenization of aperiodic heterogeneous materials. *Composite Structures*, 199, 53-62.

Praveen, M., Ambika K. P., Pavithra, P., Barried, T., & Varsha P. (2016). A comparative study on waste plastics incorporated concrete blocks with ordinary concrete blocks. *International Research of Journal of Engineering and Technology (IRJET)*, 3(5), 1894-1896.

Safinia, S. & Alkalbini, A. (2016). Use of recycled plastic water bottles in concrete blocks. *Creative Construction Conference*, 115-119.

Shiri, N. D., Ranjan, V.K, Pais, N. L. & Naik, V. (2015). Processing of waste plastics into building materials using a plastic extruder and compression testing of plastic bricks. *Journal of Mechanical Engineering and Automation*, 5 (3B), 39-42.

Singh, L. B., Singh, L. G., Singh, P. B. & Thokchom, S. (2017). Manufacturing bricks and waste plastics. *International Journal of Engineering Technology Management and Applied Sciences*, 5 (3), 426-428.

Shoubi, M. V., Shoubi, V. M. & Barough, A. Z. (2013). Investigating the application of plastic bottles as a sustainable material in building construction. *International Journal of Science Engineering and Technology Research*, 2 (1), 28-34.

Teves, C. (2018). *Waste treatment facility urgently needed in Boracay*. Philippine News Agency. https://www.pna.gov.ph/articles/1032831

The Constructor (2022, August). *Standard specifications of hollow and solid concrete blocks*. https://theconstructor.org/concrete/hollowsolidconcreteblocksspecification/54785/#:~:text=These%20are%20used%20as%20load,2%20respectively%2C%20at%2028%20days.

Waroonkun, T., Puangpinyo, T., Tongtuan, Y. (2017). The development of a concrete block containing PET plastic bottle flakes. *Journal of Sustainable Development*, 10 (6), 186-199.

Wonderlich, S.M. (2014). *Strength of concrete masonry units with plastics bottle cores*. Published master's thesis, Kansas State University, Manhattan, Kansas.

Ullah, M.I. (2019). Basic statistics and data analysis: Randomized complete block design. https://itfeature.com/design-ofexperimentdoe/randomized-complete-block-design