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Durability analysis of combining waste paper and recycle plastic in hollow block

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The number of waste has been continuously increasing especially that the government or the people did not give any emphasis as to how these wastes can be recycled. The researcher came up with the idea to participate actively in this matter by a comparative research on variations of materials being partially replaced in a hollow block such as; a) recycled plastics b) waste papers to reduce the number of waste and also to lessen the aggregates withdrawal. This exploratory study is attempted to infer the durability of the hollow blocks added with a waste aggregate based on its compressive strength. The results interpreted are sufficient as a non-load bearing hollow block. The results showed that as the percentage of waste added increases, its compressive strength decreases. As for the relationship of the number of curing days to the hollow blocks' compressive strength, it shows that as the number of the curing days' increases, the compressive strength decreases. The hollow blocks containing paper and plastic waste could benefit the environment, community, science and the field of innovation, if it qualifies the given specific objectives of the research.

Keywords: Aggregates, Compressive Strength, Hollow Block

1. INTRODUCTION

`"Increasing sand extraction, trade, and consumption pose global sustainability challenges" (p. 970), as stated by Torres, Brandt, Lear and Liu (2017) to inform the effects and consequences of sand extraction. Sand and gravel is believed to be the most extracted materials in the world, beating fossil fuels and biomass. In the year 2010, countries excavate 11 billion tons of sand for construction use alone due to its higher demand on the world market. Despite the benefits of sand for economic progress, it also contributed to the depletion of species most specifically, the

Ganges River Dolphins. In addition to that, the Southeast Asia is experiencing destabilization, land erosion, and sand scarcity due to the illegal extraction of the said natural resource. Moreover, the Philippines is also dealing with the same problem in illegal mining of black sand. The Department of Environment and Natural Resources (DENR) exposed and stopped the operation of the Aklan River Dredging Project during the 1st of February 2017, which led to a confiscation of about 1,200 cubic meters of sand materials without any required permits from the local government. The illegal operation resulted to the depletion of natural resources in the country as well as destruction in the environment and nature (DENR, 2017).Countries all over the world cause certain serious environmental problems. Majority of the accumulating waste are the plastics and papers. The world's annual consumption of plastic materials has increased from around five million tons in the 1950s to nearly 100 million tons in 2001 (Rebeiz, Fowler & Paul, 1994). Paper on the other hand, generates an enormous amount all over the world. In India, 0.7% of total urban waste generated comprises of paper and UK produces over 1.5 million tons of waste paper annually (Ahmad S., Ahmad R., Malik & Wani, 2013). The researchers came up with the idea of replacing sand with plastic and paper in a concrete hollow block to minimize the excavation of sand and also to reduce the number of waste.

2. LITERATURE

This chapter presents related literature and studies after the in-depth search done by the researchers. This chapter includes the literatures and the conceptual framework, which provides information in order to fully understand the study being presented about the compressive strength of the experimental hollow block.

- Commercialized Concrete Blocks
- Advantages and Disadvantages of Plastic in a Concrete Hollow Block
- Paper as a Partial Replacement of Coarse Aggregate
- Advantages and Disadvantages of Paper in a Concrete Block

3. METHODOLOGY

The method of this research is focusing on the production of the experimental hollow blocks which includes the recycle plastic and waste paper as partial aggregates. The results gathered were presented in graphs and tables. The average of the results was calculated as well as the p-value which indicates that there is a significant change in the compressive strength value as the percentage of the added waste increases or decreases using the analysis of variance or ANOVA: single factor with the confidence level of 95%.

Production of the Concrete Hollow Block The fundamental ingredients for the hollow block mix are cement and sand. The concrete hollow blocks weighed 14 kilograms and had the proportion of 1:7 cement to sand. In this research, sand was partially substituted with a waste fine aggregate: shredded PET plastics and newspapers. The CHB had the dimension of 40 cm (length) by 20 cm 22 (width) by 10.16 cm or 4 inches (thickness). The holes found on the CHB, measured 8.0 cm by 3.0 cm. The cement used was APO Portland cement and a fine sand durite from Alcoy for the sand. There were three concrete hollow block (CHB) mix: 0% or no added PET and newspaper, 3%, 5%. There were a total of 36 hollow blocks produced (Appendix A). Three hollow blocks were tested in each variation per curing days. Each CHBs had different measurements for the ingredients depending on the percentage of the waste aggregates added. In Figure 6 presented the process of the production of concrete hollow blocks. 3.2.1 Mixing of the Dry Materials. In Table 7, the manufacturing of CHB with the following variation: 0%, 3% and 5% of substituted aggregate. For the 0% variation, a total measurement of 21.0 kilograms' cement, 147 kilograms of sand and no shredded PET bottles and newspapers were added.

Table 1: Measurements of each variation corresponding to its components

Variation (%)	Cement (kg)	Sand (kg)	Plastic (kg)	Paper (kg)
0%	21.0 kg	147 kg	0 kg	0 kg
3%	21.0 kg	142.6 kg	2.21 kg	2.21 kg
5%	21.0 kg	139.7 kg	3.68 kg	3.68 kg

3.1 Curing Process

The CHBs were placed in an open area as shown in Figure 7. Each CHB was labelled with their corresponding variation and curing days. The curing days of CHB were 29th and 45th to determine if there was a significant change in its compressive strength as the number of curing days increased. The CHBs were covered with a tarpaulin to avoid direct sunlight and it was sprinkled with water once a day to help conserve the moisture inside.

3.2 Compressive Strength Test

After the curing of the CHB for 29 and 45 days, its physical attributes; length, width, thickness, and weight were measured for the computation of the compressive strength. The hollow blocks were later lined for the testing of its compressive strength. Each compressive strength of the hollow block was obtained through Compression Machine which took place at the ASTEC Materials Testing Corp. The compressive strength was based on ASTM C-140.

4. RESULT AND DISCUSSIONS

This chapter includes the results and observations of the researchers corresponding to the conducted study. The data are presented using a graph and table to emphasize and differentiate the durability of the hollow block per variations in terms of its compressive strength. The formal report of the ASTM C-140 is found on the Appendix C and B. Figure 16 shows the graph of the compressive strength values for each variation. The Anova: Single Factor with 95% confidence limit was used to evaluate whether there is a significant change in compressive strength as the percentage of the added PET and newspaper increases or decreases.

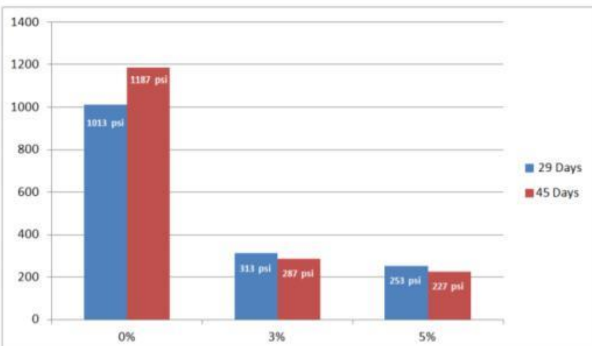

Figure 1: Standard deviation of the results

For the 29 curing days, the compressive strength value for the variations, 0%, 3%, and 5% are respectively the following: 1013 ± 176.7, 313 32.1, 253 ± 49.3. According to the Appendix A, the result for the p-value is 0.000225 which implies that there has been a significant change in compressive strength as the added PET and newspaper increases or decreases. Thus, as the percentage of added PET increases, the compressive strength value decreases. For the 45 curing days, the compressive strength value for the variations, 0%, 3%, and 5% are respectively the following: 1187 ± 144.7, 287 ± 30.6, 227 ± 15.3. According to the Appendix A, the result for the p-value is 1.53266E-05 which also implies that there has been a significant change in compressive strength as the added PET and newspaper increases or decreases. Therefore, as the percentage of added PET increases, the compressive strength value decreases.

4. RECOMMENDATIONS

The researchers suggest some further research such as; minimizing the percent of PET bottles and newspapers as an efficient partial replacement of sand in a concrete hollow block. Testing the experimental concrete hollow block in terms of water absorption, thermal conductivity, and tensile strength to determine the effectiveness and durability of a concrete hollow block not only in terms of compressive strength. Water cement ratio is also another factor that can be treated in order to see the best water cement ratio to reach both strength and workability, consistency of mixing the dry and wet components of the materials. Lastly, to explore different types of plastics with the combination of paper to explore different outcomes.

5. CONCLUSION

Based from the data gathered from the experiment. The compressive strength of the concrete hollow blocks decreased as the percentage of waste plastic and paper were increasingly added from 0%, 3% and 5%. Different curing days also affect the compressive strength of the concrete hollow blocks. As the curing days go longer, the compressive strength of the concrete hollow blocks weakens.

REFERENCES

Akinyele, J. & Toriola, I. (2018). The effect of crushed plastics waste on the structural properties of sandcrete blocks. *African Journal of Science, Technology, Innovation and Development*. 10(6), 709-713.

Akinwumi, I. & Gbadamosi, Z (2014) Effects of curing condition and curing period on the compressive strength development of Plain Concrete. *International Journal of Civil and Environmental Research (IJCER*), *1 (2), 83-99.*

Akinwumi, I., Olatunbosun, O., Olofinnade, O. & Awoyera, P. (2014). Structural evaluation of lightweight concrete produced using newspaper and office paper. *Civil and Environmental Research*. *6*(7), 160-168.

Balwaik, S. A., & Raut, S. P. (2011). Utilization of Waste Paper Pulp by Partial Replacement of Cement in Concrete. *International Journal of Engineering Research and Applications*, 1(2), 300-309.

Birhane, S., Mesfin, M., & Koshe, W. (2011). Experimental study on some mechanical properties of papercrete concrete. *Advances in Materials*, 6(1), 1-6.

Choi, W.Y., Kim, Y.G., Moon, D.J., Lachemi, M. (2009). Characteristics of mortar and Concrete containing fine aggregate Manufactured from recycled waste Polyethylene Terephthalate Bottles. *Construction and Building Materials. 23*(8), 2829-2835.

Choudhary, V., Tandale, A., Patel, M., Patil, R. & Guttedar, A. (2018). Utilization of waste paper-pulp by partial replacement of sand in concrete. *International Journal of Scientific & Engineering Research* (9), 363-167

Dawood, A. O., & Adnan, H. M. (2019). Experimental investigation of using PET wastes as tension bars in reinforced concrete beams. Journal of University of Babylon for Engineering Sciences, 27(1), 247 - 261.

Frigione, M (2010). Recycling of PET bottles as fine aggregate in concrete. *Elsevier Journals. 30(6), 1101-1106.*

Fuller, B., Fafitis, A., & Santamaria, J. (2006). Structural properties of a new material made of waste paper. Paper presented in AEI 2006: Building Integration Solutions Proceedings of the 2006 Architectural Engineering National Conference (pp. 10) https://doi.org/10.1061/40798(190)10

Gallardo, R. & Adajar, M.A. (2006, December). Structural performance of concrete with paper sludge as fine aggregates partial replacement enhanced with admixtures. Paper presented at the International Symposium on Environmental Engineering and 5th Regional Symposium on Infrastructure Development. Retrieved from https://www.researchgate.net/publication/301790125

Gorgis, I. N., Zaki, H. M. & Salih, S. A. (2017). Properties of papercrete. *ARPN Journal of Engineering and Applied Sciences*, 12(24), 7400-7412

Ismail Z. & Al-Hashmi E. (2008). Use of waste plastic in concrete mixture as aggregate replacement. *Waste Management 28,* 2041-2047.

JibraM. & Peter, F. (2016). Strength and behavior of concrete contains waste plastic. *Journal of Ecosystem and Ecography*, *6*, 2-4.

K oski, J. (1992). How concrete block are made. *Masonry Construction,* 374-37