Recycling Ocean Debris PET bottles as Partial Replacement of Fine Aggregate on Concrete

Abstract

The researcher conducted this experiment to see if it was possible to substitute part of the fine aggregate in concrete with shredded PET plastic to provide a safe and eco friendly way of disposing the plastic. The researcher used a scale to measure the correct amount of fine aggregate that had to be substituted with PET. The researcher decided to substitute -1% ,-4% and -8% of the fine aggregate in the samples and a control sample was also made to compare the results. In other experiments conducted the researcher concluded that when the PET substitute was over 4% the compressive strength would decree. The researcher prepared the concrete mixes and poured the mixes one third of the way and poked it with a metal bar 25 to make sure all the spaces were filled and there were no air bubbles and repeated until the mold was filled completely. After the concrete cured for 24 hours, they were submerged in water for 28 days. The samples can be tested at 7 days and 28 days. In this case the researcher decided to test the samples at 28 days. After the 28 days the samples were taken to a testing and ground research center. Then the concrete was submitted to a compressive strength test to see how much the samples would resist before braking. Finally, the researcher took notes of the results in the computer and packed every sample in identified bags.

Introduction

It is very important to find more sustainable ingredients to be used as aggregates in concrete to make it more eco friendly (Ajamu, Ige and Oyinkanola, 2018) . In this experiment "Both plastic bottles and bags showed some potential to be used as a partial replacement of coarse aggregate in the concrete mix." (Adela, Berhane, Gobena, 2020) . The immense amount of plastic waste pollution in our planet has become a daunting challenge to overcome. At the same time "concrete is one of many versatile construction materials. Seeking aggregates for concrete and sustainability of the construction industry is very essential" (Kolhapure, et. at., 2018). The main objective of this investigation was to contribute with a solution to the plastic contamination crisis in a useful way. "The slow degradation property of waste polymer materials causes a waste disposal crisis from environmental viewpoint, but it may appear to be valuable property as constructional material and could be an important answer to this environmental emergency (Rahman, Mahi and Chowdhury, 2013) . Previous studies have substituted in part the fine aggregates in concrete with PET plastic fibers with some success (Awoyera and Adesina, 2020; Safinia and Alkalbani, 2016). It is observed that replacement of sand by shredded pieces of PET plastic bottles waste improved the compressive strength unto 5% replacement by about 25% along with improvement in split tensile and flexural strengths (Kolhapure, Chavan, Irshad, Amar, Patel, p.1259, 2018).

Methodology

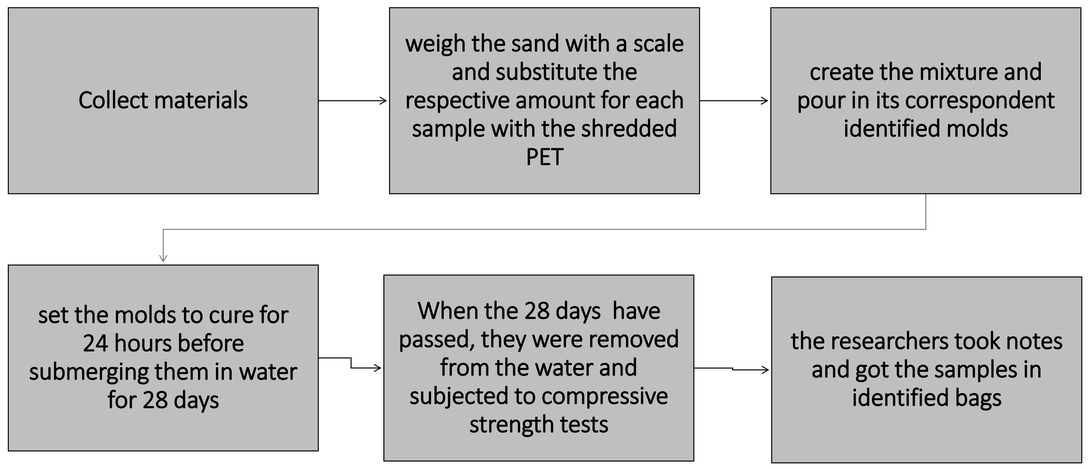

Figure 3. substituting fine aggregate

Figure 4. substituting fine aggregate

Figure 5. Concrete mix

Materials

- **Portland cement - amount to be determined**
- **Coarse aggregates (grabble) – amount to be determined**
- **Fine Aggregate (river sand)- amount to be determined**
- **Tap water- amount to be determined**
- **shredded ocean collected PET bottles**
- **1 shovel**
- **recycled cardboard for use as a protective surface**
- **water hose**
- **2 five-gallon buckets**
- **Several cylinder molds (one for each sample)**
- **Compressive strength measuring machine**
- **Shredded PET plastic**
- **Metal bar**
- **Electric drill with concrete mixing attachment**

Figure 1. Materials

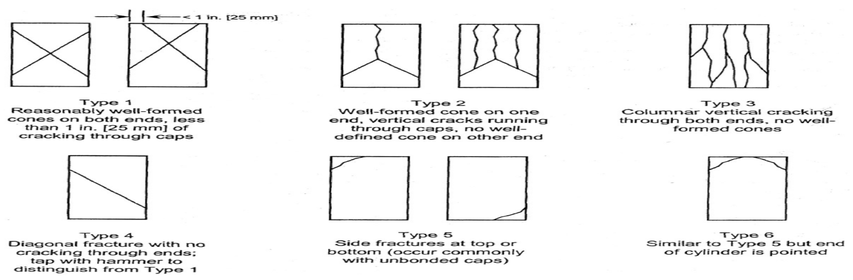

Figure 2. Image of reference retrieved from: https://owlcation.com/humanities/ASTM-C39-Compressive-Strength-of-Concrete-Cylinders

Result

Table 1. PSI and Rupture result per concrete specimen

Specimen	Rupture	Result	PSI
Control (1)	2	14653	1165
Control (2)	3	21277	1692
-1% (1)	3	5695	453
-1% (2)	3	7676	610
-4% (1)	3	10532	837
-4% (2)	3	14148	1125
-8% (1)	2	3473	276
-8% (2)	3	529	42

Figure 6. After curing time blocks

Figure 7. Testing the concrete

Figure 8. Testing the concrete

Figure 9. Testing the concrete

Figure 10. Testing the concrete sample

Figure 11. Testing the concrete sample

Figure 12. Testing the concrete sample

Conclusion and Recommendation

The hypothesis was rejected because the results of the investigation were not the expected ny regulations to confirm that PET plastic could be used as the replacement for the fine aggregate in a concrete mixture with the proportions used. During the experiment, the concrete formula used was a proportion of 1: 2: 3: (cement: fine aggregate: coarse aggregate) and ¾ parts of water. The researcher recommend repeat the experiment using different proportions, in order to get more precise results, and determine if it is possible top use shredded PET plastics as a substitute for the fine aggregate.

Credits: All graphs, tables and photographs were created and/or taken by the researcher. (2020 - 2021)

References

Adela, S., Berhane, M. & Gobena B. (2020). Plastic Wastes as a Raw Material in the Concrete Mix: An Alternative Approach to Manage Plastic Wastes in Developing Countries. International Journal of Waste Resources, Vol. 10, Issue 3. 1-7

Ajamu S.O., Ige J.A., Oyinkanola T.M. (2018). Effect of Waste (PET) Bottle Fibers on the Properties of Concrete. IMPACT: International Journal of Research in Engineering & Technology, Vol.6, Issue 9. 1-8

Awoyera P.O., Adesina A. (2020) Plastic wastes to construction products: Status, limitations and future perspective. Elsevier, 12(2020). 1-10

Kolhapure B.K., Chavan, A., Irshad A. , Amar B. , Patel H. (2018) Eco-Friendly Concrete By Partial Replacement of Sand by Shredded Pieces of Plastic Bottles. International

Rahman M.M., Mahi M.A., Chowdhury T.U. (2013). Utilization of waste PET bottles as aggregate in masonry mortar. International Journal of Engineering Research & Technology, Vol. 2, Issue 11

Safinia, S., & Alkalbani, A. (2016). Use of Recycled Plastic Water Bottles in Concrete Blocks. Procedia Engineering, 164, 214-221. doi: 10.1016/j.proeng.2016.11.612