Use of Plastic as a Replacement of Fine Aggregates in Concrete Admixtures

Tanayshalí Meléndez Santana, Civil Engineering Student
Advisor: Gustavo E. Pacheco Crosetti, PhD, PE
Polytechnic University of Puerto Rico
Department of Civil & Environmental Engineering and Land Surveying

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ABSTRACT

Current legislation established that 35% of plastic waste must be recycled on the island (ADS, 2017). These materials damage the environment since they have no biodegradable properties (Rodriguez, 2010). This research studied the feasibility of using type 5 shredded plastic, currently not recycled in PR, as a replacement of fine aggregate in concrete admixtures, in order to provide a recycling alternative that may to reduce their disposal. A normal resistance admixture was designed as a control sample, and several admixtures replacing 0% to 30% by volume of fine aggregate were developed. The samples were cured and tested in compression at different ages in accordance with the American Society for Testing and Materials (ASTM). The results showed that shredded plastic type 5 could be a suitable replacement for part of the fine aggregate in concrete admixtures, since the resistance obtained was similar or better than the control sample.

INTRODUCTION

This project will focus on making concrete admixtures replacing fine aggregates with plastic (preferable number 3 to 7, currently not recycled in Puerto Rico) in order to contribute to the reduction of plastics as a solid waste that ends up in landfills. By reducing the disposal of this material, one may contribute not only to the reduction of the impact of the plastic on landfills, but also to the reduction of the impact that plastic carried out from landfills has in the internment, wildlife, and

OBJECTIVE

The objective of this project is to study the effect of replacing fine aggregate by threaded plastics in concrete admixtures in the mechanical and physical properties of the hardened concrete in order to assess if the obtained product is a viable construction material.

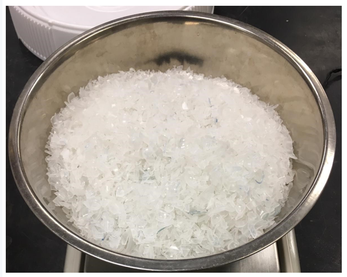
METHODOLOGY

The methodology that was used for this research was divided into seven phases.

I.Study and practice of material testing procedures according to ASTM

- ASTM C136
- ASTM C128
- ASTM C702
- ASTM C192
- ASTM C127
- ASTM C143
- ASTM 1064
- ASTM D 75
- ASTM 172

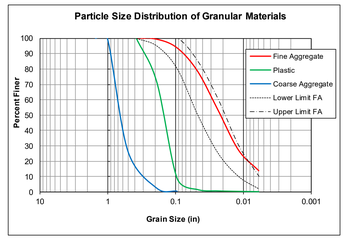
II.Industrially shredded plastic material procurement




Shredded plastic.

III. Material characterization

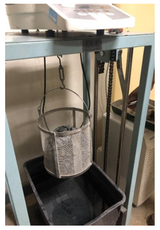

Equipment for sieve analysis.



Particle size distribution for coarse, fine aggregates and polypropylene plastic.

Moisture content for fine and coarse. aggregates.

Pycnometer test for cement.




Specific gravity for both aggregates.

IV. Design of admixtures


Total cylinder samples: 140.
2x20 cylinders for control samples;
5x20 cylinders with plastic replacement
5%, 10%, 15%, 20%, 25%, and 30% FA replacement by volume

Design parameters:
Target f'c = 4000 psi
W/C ratio = 0.44
Water content = 325 lb/yd^3

V. Curing

VI. Tests on fresh concrete

Temperature test

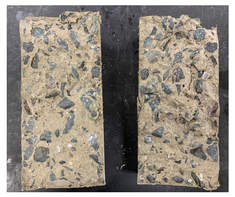
Volumetric test

Slump test

Air content

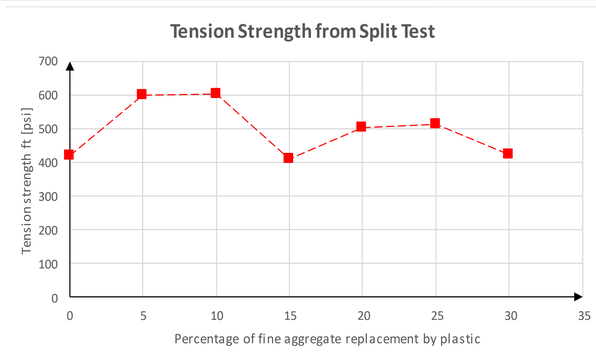
VII. Tests on hardened concrete at different

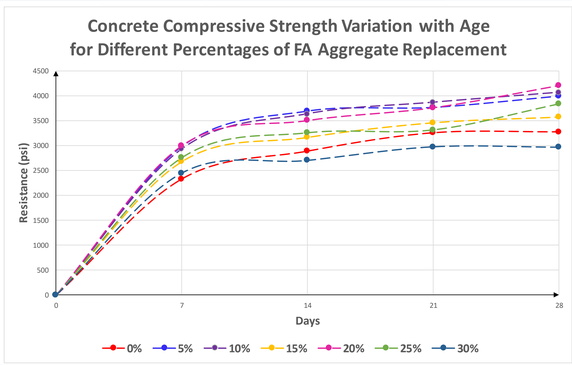

Compression test, 84 total compression tests.

Split (tension) test (ft) at 28 days, 2 cylinders per admixture (14 total tests).

ANALYSIS & RESULTS





The chart summarizing the results of the experiments shows the following:

- Admixtures with shredded plastic exhibit a compression resistance comparable to the control admixture, without plastic., both in compression and in tension.
- The greater the substitution of fine aggregates, the lower the resistance of the concrete.
- The results of 5% to 25% of the plastic replacement obtained larger compressive resistance than the control sample..
- The results of 30% of plastic replacement shows lower value of resistance than the control sample. This may indicate that a replacement of up to 25% would result in safe admixtures. it is important to mention that the 30% sample had compaction problems, evidenced by the fact that many spaces were present when the concrete cylinders were removed from the mold. So, further investigation is required to establish a proper limit of recommended % replacement.

CONCLUSION

The results demonstrate that, in term of resistance, the use of shredded plastic type 5 as a replacement of fine aggregate in concrete admixtures, up to a 25% replacement by volume, could result in a concrete admixture of adequate resistance for normal construction. These results indicate that a deeper study of the use of plastics in concrete admixtures is extremely advised.

RECOMMENDATIONS

As the results showed the feasibility of using shredded plastic as replacement of fine aggregate, to continue an deepen the research is advisable. Recommended avenues are:

- Widen the range of replacement %.
- Perform other test beside compression and tension (i.e. permeability)
- Use other type of industrially shredded plastics.

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