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 help 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. The use of plastics in concrete admixtures is extremely advised.

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.

METHODLOGY

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 C123
- ASTM C123
- ASTM C127
- ASTM C128
- ASTM C136
- ASTM C27
- ASTM C340
- ASTM D 75
- ASTM 164

II. Industrially shredded plastic material procurement

III. Material characterization

- Particle size distribution of concrete materials
- Moisture content for fine and coarse aggregates
- Concrete compressive strength variation with age for different percentages of FA aggregate replacement
- Tension strength from split test

IV. Design of admixtures

- Design parameters:
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V. Curing

- Specific gravity for both aggregates
- Total cylinder samples: 140
- 28 cylinders with plastic replacement: 5%, 10%, 15%, 20%, 25%, and 30% FA replacement by volume

VI. Tests on fresh concrete

- Temperature test
- Volumetric test
- Shrink test
- Air content

VII. Tests on hardened concrete at different ages

- Compression test, 34 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 compression 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 terms 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 deeper 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.

REFERENCES


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