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Sulfuric Acid Effect on the Mechanical Properties of Concrete Containing Crumb Tires and PET

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ABSTRACT: During two decades ago, it is focused on the use of various sorts of waste in the construction industry and many pieces of research are conducted in this field. With this regard, using wastes not only have benefits for the environment but also cause improvement in the properties of final goods. One sort of the waste using in the construction industry is plastic. Recycled plastics can be used as an aggregate in concrete and some concrete mechanical properties such as resistance to erosion caused by sulfuric acid attack to improve. In this study, the experimental works were conducted on concrete samples containing PET and tire rubber and their resistance against sulfuric acid attack were investigated. The concrete samples immersed in diluted sulfuric acid (pH≈1) and some tests such as modulus of elasticity, splitting tensile strength, compressive strength, mass variation and ultrasonic wave velocity in intervals of 20, 40 and 60 days were conducted. The results were analyzed and evaluated. To determine the amount of erosion concrete, we measured variations of the weight and compressive strength and ultrasonic velocity. The results showed that replacement of PET with aggregate positive impact on the strength of concrete is subjected to sulfuric acid.

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1- Introduction

Considering the widespread production of tires and PET bottles made from polyethylene terephthalate, as well as the long time needed to decompose waste resulted from these materials in nature, provide engineering solutions for recycling and reuse of these consumables, is the main reason for this research.

2- Methodology

2- 1- Standard materials and tests used

The standards used in this research are ASTM C33 [1] for grain size distribution, ASTM C125 [2] for fineness modulus and ASTM C496 [3] for concrete tests.

2- 2- Materials

2- 2- 1- Gavril

The gravel consumes sharp edges, with dry density of 2.7, water absorption of 3% and maximum aggregate size of 12.5 mm.

2- 2- 2- Sand

The used sand is also of the river type, with a size of 0.42-4.76 mm and in accordance with the ASTMC33 standard [1]. Dry density is 2.7, the water absorption is 3% and the sand fineness modulus is 2.75.

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2- 2- 3- Cement

Portland cement used in this study is type II cement of plant product Shahrood, has a specific weight of 3150 (kg/m^3) and specific surface (determined by Blaine method) is 306 (m^2/kg).

2- 2- 4- Water

In this project, water supplied from drinking water (tap water).

2- 2- 5- Superplasticizer

In this study, the third generation of superplasticizer based on carboxylic ether was used. It was dark with cloudy color and the density at 20 ˚C is 1.1 (kg/m^3). The amount of chloride ion in compound is less than 0.1 percent.

2- 2- 6- Crumb rubber

Crumb rubber particles used as granular rocks in the study, obtained by grinding scrap tires for cars which have been obtained by industrial machines.

The maximum particle size of crumb rubber was 3 (mm) and density was calculated about 1142 (kg/m^3).

2- 2- 7- PET[1] particles

The PET particle used as fine aggregates in this research

1 Polyethylene terephthalate

is derived from the grinding of PET bottles. The particles collected from waste PET bottles, washed and then grinding them have been obtained by industrial machines. PET maximum particle size was 4.75 (mm) and specific gravity calculated about 465 (kg/m^3) respectively.

3- Results and Discussion

In this research, various experiments including slump, elasticity modulus, tensile strength, compressive strength, weight variation and ultrasonic velocity were used. According to these experiments, the performance of concrete samples containing 0, 5, 10% PET and 15% crumb rubber in erosive and acidic environments was investigated and the following results were obtained:

- PET and crumb rubber particles due to their shape and sharp corners, reducing the slump of concrete samples so that by increasing the replacement rate, further reducing the slump in values was observed.
- Tensile strength of concrete decreased with increasing replacement of PET particles, which can be caused by low adhesion with the cement paste compared to natural aggregates.
- With increasing replacement of PET with natural aggregates in concrete, modulus of elasticity can be reduced because of the lower modulus of elasticity PET flakes to natural aggregates as well as the cohesion less plastic particles and aggregates are normal.
- Compressive strength of concrete containing crumb rubber with different amounts of replacement PET was investigated. Obtained result showed that concrete containing a large amount of plastic particles, although less resistant to immersion at an early age had a concrete reference, but after exposure has maintained its resistance in acidic environments so that after 60 days soaking similar resistance (with a difference of about 2%) showed concrete reference.
- After variations the weighted sample after a 60-day immersion in an acidic environment was concluded. Immersion with increasing age, weight decreases and this percentage decreases for samples containing higher percentages of replacement PET is less than about 5 percent.
- With the addition of crumb rubber and Pat the velocity of ultrasonic waves is reduced to 30% .and with aging immersion samples containing higher percentages more PET have retained their integrity and become less erosion.

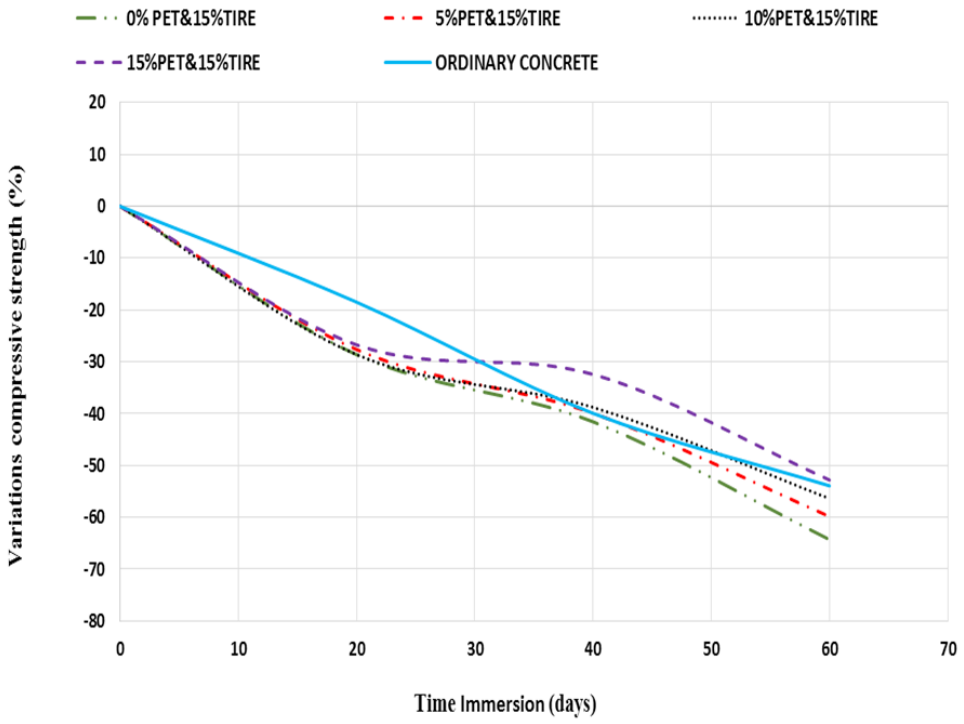

Figure 1. Variations the values of the compressive strength of samples immersed in acid for normal concrete, normal concrete containing crumb rubber, crumb rubber and concrete containing different percentages of replacement PET

4- Conclusions

Consequently, it could be said that, concrete containing crumb rubber with higher levels of replacement PET similar resistance.

After exposure shown in the acidic environment and about 5 percent less weight to lose and maintain their integrity, which can be useful in the production of products with expected such functions.

Also, according to the desired properties such as sound insulation and environmental protection can be used to create synergies and sustainable development, production, employment and generating economic effective step to be taken.

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