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ScienceDirect

Procedia Manufacturing 22 (2018) 347–351

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

11th International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October 2017, Tirgu-Mures, Romania

Wastes as aggregate substitution in polymer concrete

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Abstract

The experimental study was effectuated on polymer concrete with wastes as substitution of aggregate. The polymer concrete was prepared with epoxy resin and aggregates in two sorts. Fly ash was added as filler and aggregate sort 0-4 mm was replaced in different dosages by saw dust and chopped PET bottles. The density and compressive strength were experimentally determined. The influence of waste as substitution of aggregate on density, workability and compressive strength was analyzed and compared with a control mix of polymer concrete prepared with natural aggregates and fly ash as filler. The wastes used as aggregate substitution decreased the density of polymer concrete, indicating a lightweight concrete for all mixes. The compressive strength for polymer concrete with wastes as aggregates substitution were closed as values to the control mix.

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Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.

Keywords: PET waste; saw dust; epoxy resin; polymer concrete; compressive strength.

1. Introduction

Polymer concrete is widely used in building industry due to its performing properties such as high strength, resistance to corrosive agents, resistance to frost, good abrasion behavior, rapid hardening, easy preparation, etc. [1,2,3,4,5]. Polymer concrete has high possibility of using in different domains such as overlays of bridges, building

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Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.
10.1016/j.promfg.2018.03.052

and high-ways repair, panels in structural building or as decorative elements, sewer pipes, underground tunnel, swimming pool, tanks, etc. [6,7,8]. Polymer concrete is a composite that is obtained by mixing a resin with aggregate. The matrix is given by the polymer which acts as binder of the components, that can be different types of natural aggregates, powders, fibers, nano-materials, etc. [9,10,11]. Many studied had characterized the polymer concrete of different compositions. The influences of resin type and dosage, the effects of different types of fillers, fibers or nano-particle were analyzed by researchers in order to increase the mechanical or durability properties and to reduce the costs [12,13,14,15]. In order to use the wastes and protect natural resources, aggregate can be replaced in different percentages by natural waste or sub-products, such as silica fume, recycle glass, fly ash, polystyrene granules, saw dust, PET particle, etc.[16,17,18,19,20].

In the article, are presented the experimental results obtained on polymer concrete with two types of wastes used as substitution of aggregates. The effects on the density, workability and compressive strength were investigated by testing different mixes in which dosages of sand between 25% and 100% were replaced by saw dust and chopped PET bottle.

2. Experimental program

For the experimental research a control mix of polymer concrete and two mixes of polymer concrete with aggregate substitution were prepared. The control mix of polymer concrete (CPC) was prepared with epoxy resin in a dosage of 12.4 %, fly ash as filler in a dosage of 12.8 % and natural river aggregates in two sorts: sort I (0-4 mm) and sort II (4-8 mm) in same percentages both, 37.4 % (all components are expressed as percentages from the total weight of the mix). The epoxy resin was a Romanian product from POLICOLOR S.A. Bucuresti which is activated by a hardener type ROPOXID P401. The fly ash is from Electric Power Plant Holboca Iasi and it was also used in previous experimental researches of authors [21, 22].

The two mixes with wastes were prepared with the same dosage of epoxy resin, fly ash and sort 4-8 mm, only the sort 0-4 mm were replaced by saw dust and chopped PET bottle. In the first mix the aggregate sort 0-4 mm was replaced with saw dust in dosages of 25%, 50%, 75% and 100% by volume (noted SDPC1 for a substitution of 25% to SDPC4 for a substitution of 100%). In the second mix the aggregate sort 0-4 mm was replaced with chopped PET bottle in dosages of 25%, 50%, 75% and 100% by volume (noted PETPC1 for a substitution of 25% to PETPC4 for a substitution of 100%). For preparing concrete the aggregates, fly ash and waste were mixed together; the epoxy resin was combined with hardener and was introduced in the mix. According to European standard the samples type cubes of 70 mm sizes were poured and were demoulded after 24 hours [23]. At the age of 14 days the samples were measured, weighed and tested in compression. The density of hardened concrete mixes and compressive strength (f_c) were determined on three samples for each test, according to standard prescription [24].

3. Results and discussions

3.1. Physical characteristic

The density of hardened polymer concrete with aggregate substitution in both cases (with saw dust and chopped PET) was under 2000 kg/m^3, indicating a lightweight concrete and varied between 1919 and 1762 kg/m^3 for the mix with saw dust and between 1948 and 1703 kg/m^3 for the mix with chopped PET, Fig. 1. Except first mix of PETPC, all values of density of polymer concrete with PET are smaller than that of polymer concrete with saw dust.

The density of both mixes with substitution was smaller than that of control mix, which had a density of 2117 kg/m^3.

The workability of fresh concrete increased with increasing the PET dosage. In the case of polymer concrete with saw dust the workability was decreasing with the increase of waste dosage.

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