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Combined Effect of Fly Ash and Fibers on Properties of Cement Concrete

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Abstract

Worldwide the production and consumption of building materials have increased in the last decades. Wastes of different types (such as fibers, powders, granules, etc.) are used for obtaining construction materials. Concrete is one of the most used materials and in time it diversified. Near the ordinary concretes today a lot of new types of concretes had occurred. Fiber reinforced concrete is a special concrete in which wastes can be used for totally or partially replacement of mix components. For studying the influence of wastes on mechanical properties of cement concrete (green concrete), different dosages of cement were replaced by fly ash and also glass fiber or polyester fiber were added. The compressive strength, flexural strength and split tensile strength were experimentally determined. According to test results, the concrete with 10% replacement of cement with fly ash and fiber presented better results of compressive strength than the concrete without fiber. Glass fiber increased flexural strengths for small dosages of fly ash. Higher dosages of fly ash and glass fiber decreased the mechanical strength. Polyester fiber had increased the values of all flexural strength of fly ash cement concrete.

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Keywords: fly ash concrete; glass fiber; polyester fiber; compressive strength; flexural strength; split tensile strength.

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1. Introduction

In the material construction industry the usage of different wastes have become a necessity because in time it had generated a lot of wastes and had consummated a lot of energy and raw materials [1, 2]. Different types of wastes are used for obtaining building products. The industrial wastes, such as fly ash [3, 4, 5, 6, 7], slag [8, 9], silica fume [10, 11, 12, 13], tire wastes [14, 15] are used for improving the concrete properties or replacing cement, a pollutant component. Wastes obtained from demolitions, such as recycled aggregates are used in obtaining different building products [16, 17]. The natural wastes such as bagasse ash, banana leaf ashes, rice husk are used as pozzolanic materials for obtaining concrete [18, 19, 20, 21]. Different types of synthetic or natural fibers are used in obtaining a variety of cement composites [22-33]. Important improvement of concrete properties is possible to obtain by using combined wastes used as additions. Fibers in combination with fly ash, silica fume, etc. are very seldom used for obtaining cement composite [34, 35]. The paper presents the experimental data obtained for the mechanical properties of cement concrete with fly ash and two types of fibers and also a comparison between them and a witness composition is presented.

2. Experimental program

2.1. Materials

For preparing fly ash cement concrete with fibers a witness mix of ordinary concrete, grade C20/25 was used. The witness was prepared with: cement type CEM II 42.5 (Romanian cement), Table 1. The aggregates were in three sorts (sand 0-4 mm, 4-8 mm and 8-16 mm type river gravel). The studied fly ash cement mixes were prepared with fly ash (FA) from CET Holboca Iasi, in different dosages from 10% to 40 % as replacement of cement (noted from B1, which is the witness without fly ash and until B6), Table 1. The fly ash properties were: colour gray-black, spherical particle of diameter between 0.01 and 400 μ m, specific area of 480-520 m²/kg, density 2400-2550 kg/m³, chemical content of Si (18.3%) C (17.15%), Al (13.9%), etc. [34]. The dosage and length of fibers were chosen from previous experimental data of authors [23, 30, 34]. The fibers type glass fiber wastes of 30 mm length (L) in a dosage of 0.25% and polyester fibers of 50 mm length (L), in a dosage of 0.25% of volume-weight were introduced in the mix, separately. The samples with fly ash were noted from B2a to B6a, the samples with fly ash and glass fiber were noted from B2b to B6b and the samples with fly ash and polyester fibers were noted from B2c to B6c, Table 1.

The following mechanical characteristics were experimentally determined at 28 days, on three samples for each characteristic: compressive strength (f_c) on cube samples of 150 mm sizes, flexural strength (f_{ti}) on prismatic samples of 100x100x500 mm sizes and split tensile strength (f_{td}) on cube samples of 100 mm sizes, according to standard prescriptions [36, 37, 38].

3. Results and discussions

The results of experimental tests on hardened fly ash concrete with fibers are given in Table 1. All mixes of fly ash cement concrete with fibers had densities bigger than 2000 Kg/m³.

3.1. Compressive strength

With the increase of fly ash dosage as replacement of cement, the compressive strength decreased, in comparison with the witness, prepared without cement and fibers, Table 1. The highest values of compressive strength from all types of concrete with fly ash and fly ash with both type of fiber were obtained for a dosage of fly ash of 10% (concrete type B2), but it is smaller than that of the witness. Higher dosages of fly ash decreased significantly the compressive strength (for 40% replacement of cement with fly ash, smaller values than that of the witness were obtained for all mixes). The values of f_c for fly ash concrete with fibers were bigger for glass fiber concrete for

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