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Comparative study of the properties of mortars with recycled glass aggregates incorporated by addition and substitution

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Abstract

An investigation carried out from mirror artisans shows that in the region of Médéa in Algeria and in the absence of a factory of glass making, an important glass quantity is generated by this activity but not exploited and eventually thrown in the landfill. This study is a contribution to the valuation of this waste in the manufacturing of mortar either by substitution of aggregates, of sand by the glass, or by addition in mortar.
Six (6) different proportions (0 (reference), 25, 35, 50, 75 and 100%) of recycled glass as mass substitution of sand and three (3) others taken as addition to the reference formulation were used.
A comparison of the properties of the material made with one or the other method (substitution or addition) was realized.
By working either on constant workability or with constant W/C ratio, a comparative plan and a discussion of the properties in the fresh and hardened states, sometimes good for one case but bad for others were clarified.
At 28 days, the optimum in terms of mechanical strength was achieved for the mortar with 35% by substitution and with 10% by addition of recycled glass.

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Keywords: Mortar; Waste Glass; Physical; Mechanical; Characterisation

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1. Introduction

The recycling of used materials has become an important issue as it is a suitable way to preserve natural raw materials that are increasingly rare, reduce landfills and save energy [1,2]. The construction sector is one of the most absorber of recycling wastes and many research works on the use of waste glass as substitution of sand aggregates or Portland cement have been done [3-6]. Kiang Hwee T. & Hongjian Du [1] have tested 4 compositions up to 100% of sand substitution by waste glass; they found a reduction of the flowability and density of mortar, while its air content increases and the mechanical properties were compromised. This behavior is comparable to other research program [7-8].

In this part of the study, we examine the possibility of making a mortar with recycled glass supplied by artisan glaziers, once by substituting the sand by the glass and secondly by adding glass quantity to the mixture.

Then, this material is mechanically and physically characterized.

2. Experimental Detail

Waste flat glass sourced from local glaziers' artisans is used to manufacture a glass mortar (GM). The glass in fractions of 25, 35, 50, 75 and 100 % substitutes a mass of sand. Samples were characterized in both the fresh state, by examining the density, the air content and the fluidity, and in the hardened state by examining the compressive and the flexural strengths.

2.1. Materials

Ordinary Portland cement OPC CEM II/A 42.5 was used. The chemical composition of OPC is given in Table 1. In this study, recycled glass (RG) with a fineness modulus of 3.83, and 2.49 g/cm^3 of density is used. Its chemical composition is given in Table 1.

The natural fine aggregate used was corrected by combining rolled and crushed sands giving fineness modulus of 2.50 and a density of 2.63 g/cm^3. No superplasticizer was used.

Table 1. Chemical composition of OPC & glass (%).

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O
OPC	21.91	5.19	2.94	60.41	1.60	0.16	0.54
Glass	72.5	1.5	0.1	9.3	3	13	0.3

2.2. Mixtures preparation, casting and curing

The mortar mixed is cast in moulds of 4x4x16 cm^3. 24 h after, samples are demoulded and stored for a cure, in water with 20 C° ± 2 C° or in the free air (24 C° ± 2 C° according to the nature of the test.

It should be noted that for the same percentage of substitution, two types of mortars are studied, once by maintaining a flowability constant at 10 seconds and secondly by keeping the water/cement ratio (W/C) constant at 0.5. Mix proportions of different types of mortar are cited by M. Bentchikou et al [9].

2.3. Tests and measurements

Tests on fresh properties of GM, include flow test, air content test and fresh density are conducted respectively.

Tests on the cast specimens include shrinkage, and water absorption test and compressive & flexural strengths that were conducted according to NF EN 196 –1 at 7, 28, and 90 days, respectively.

All tests were carried out in room temperature from 20 to 28 °C.