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Impact on mechanical propreties of cement sand mortar containing waste dust cement and glass powder

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Abstract. Actually the waste management is a universal challenge. Dust generated from manufacturing processing industries is one of the major sources of total hard waste production. This paper reports the feasibility of re-utilizing dust generated from ejections particles by cemeteries replacement in mortar mixes. Compressive strength, flexural strength, water absorption and ultra-sonic pulse velocity, durability of all the mortar mixes were studied. It was observed that mortars mixes absorbed water continued until 14 days compared to control mortar (0% by volume replacement) it was at the 7day. Replacement of 5% cement dust was comparable to that of the control one. 5% cement replacement level gave the greatest flexural strength mortars. Similar trend was observed at the two percentages concentration of H_2SO_4 age of 28 days.

Keywords: Cement dust, mortar, mechanical, waste, glass powder

1 Introduction

The increasing generation of industrials waste has become a logical issue of development over the world, principally due to the strong growth of population and industrialization. The excessive production of cement manufacturing and extraction natural aggregates has serious environmental impacts. Nowadays, the researcher's study of waste utilization process becomes more development.

The objective of the present study was to estimate mechanical strength of re-using cement dust as additive in cement Portland mortar. Four dust mixtures were prepared (0%; 5%; 10%, 20%,), varying the percentage of waste added from 0 to 20% of cement weight in mortar mixture. Results obtained showed that the mineralogical composition of cement dust is poor on the CaO and SiO_2 compared to cement Portland.

Cement dust is recuperated from cemeteries. Some published literature mentions that mortars of comparable strength can be produced using a small amount of several dust to replace cement. Due to its non-biodegradable properties and its disposal issues,glass waste is developing environmental problems all over the world. As a consequence, several studies have been carried out on utilizing glass waste in the construction industry. Regarding mechanical properties, while some researchers [1,2] reported that the compressive strength is increased with the replacement ofcement and fine aggregates with waste glass. Other studies [3–4], have demonstrated that the incorporation of waste glass can negatively affect the mechanical behavior of mortars.

It was found that with up to 20% C_W (cement waste) by volume added as paste replacement, the cement mortar waste strength could be reduced by 50%, at 28-day.

1.1 Materials

The cement used in all experiments was the CEM 42;5 used in local construction. Tables 1 show the chemical and physical cement properties, respectively. The fine aggregate used for the study was a Boussada Sand (SB) with granulometric prepared according to graded sand requirements. The cement dust used is recuperated is chemical analyzed,

The particle size distribution (Fig. 1) indicates that all the SB passing through the sieve 2 mm similar than the normalized sand

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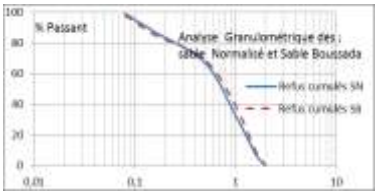

Figure 1 : particle distribution of Sand

Chemical composition of both glass powder and cement dust were examined and presented in table -ray fluorescence spectrometer.

- **Boussaâda prepared Sand**

In this step we compared flexural and compressive strengths at 28days of mortar without waste, using sands parameter, it is interesting to note that strengths varies according to the sands type ,but percentage values are similar to or slightly lower (Fig 2) than those in the control series.

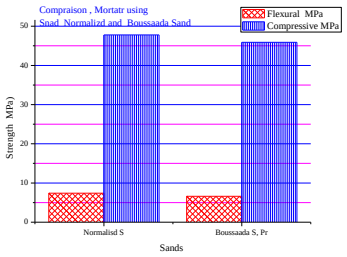

Figure 2: Comparison Normal and Boussada Sands

Table 1: Compositions properties of the tested materials.

Composition Chemical	**Bouss-sand**	**Cement**	**Dust Cement**	**Glass Powder**
SiO_2	86.95	19.98	11.30	72.20
Al_2O_3	1.92	4.84	3.99	1.55
Fe_2O_3	0.90	3.49	2.36	0.48
CaO	6.33	61.24	43.42	11.42
MgO	0,53	1.88	1.30	0.79
K_2O	-	0.65	0.74	0.43
Na_2O	-	0.08	0.09	12.85
SO_3	0,44	2.09	0.55	0.09
CaO_L	-	0.78	-	-
P_2O_5	-	0.20	0.12	-
TiO_2	-	0.21	0.16	
Residue insoluble	-	2.61	-	
P.F	2,81	5.330	35.870	

1.2 Strength measurement

Mechanical properties of mortars were verified by testing their flexural and compressive strength. The tests were carried out on the same parallelepiped samples previously used in humidity properties measurement. The result of strength of each sample was an average of three values. Different playing time curing, studied for the BS cement dust replacement

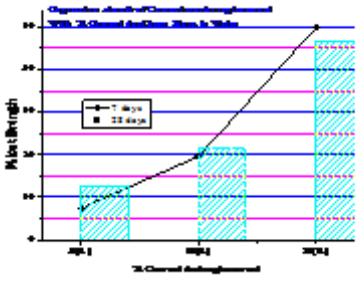

Figure 3: Compressive strength with replacement cement dust

The compressive strength of a material is the uni-axial compressive stress reached when the material fails completely. A set of three cubes were tasted in each case and the average value of these three was reported. Experimental set up for compression tests in mortar are shown in Fig. 3. Ultimate load is noted for each specimen.

- **Water absorption**

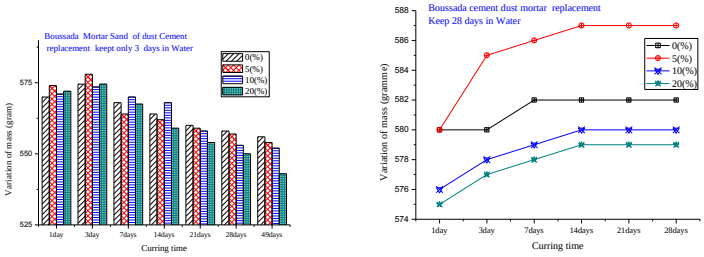

Figure 4: Mixtures and water absorption (3days in water) and (28days)

This figure resume that all mixtures compound with dust absorbed water inversely to percentage incorporated waste, and converge to stabilization 14days. The control mortar absorption stabilized after 7days.

Except control mortar (0% dust) , all other cement replaced mortars mean masses exceeded one day than stabilized 14 days, for mixtures conserved 28days in water.

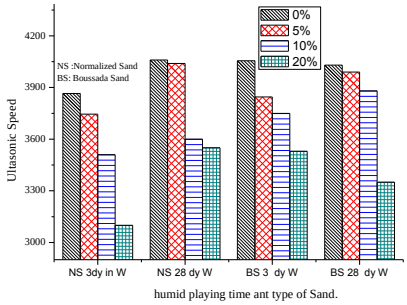

Figure 5: Mixtures and water absorption (3days in water) and (28days)

Ultrasonic speed test results are higher for samples NS (normalized sand), and BS, to those for the control series at 3days in water. Ultrasonic speed data are always lower for samples kept 3days in water than for those in 28days, although this difference is related to porosity or absorption water. US velocity are higher in samples with Bousaada Sand kept three days in water. However these speeds increased on samples contain of dust 20% and saturated water. UPV (ultrasonic pulse velocity) value of CS30 (coarse sand mixed with granite powder) and CS40 mixes are 13 and 27% higher than that of control mortar mix (FS fine sand)

respectively which indicates better packing. The reason behind this increment in UPV value was denser CSH (as shown in SEM images), which provides better medium to ultrasonic pulses [5].

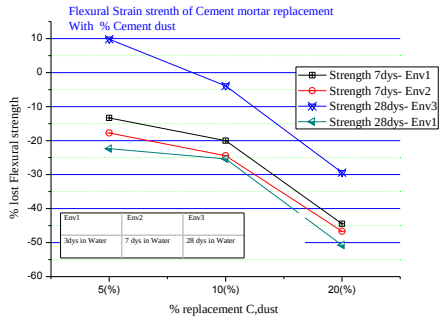

Figure 6: Mixtures and water absorption (different conditions)

Flexural strengths with the substitution of cement dust in mortars at different environment are given in Fig.6. Lower mean flexural strengths, compared to the control mortar (0% dust replacement) were obtained in environment 1 (kept three days in water), and for 20% substitution).

- **Influence of Glass powder**

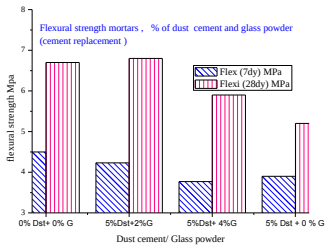

Figure 6: Mixtures and water absorption (3days in water) and (28days)

The addition of glass powder to the dust cement mortar compared to the control mortars were found important. As with 7 days and 28 days test mortar specimen gave maximum flexural strength with 5% dust cement and 2% waste glass replacement at 28days.however sand substitution with SP (Shell powder) tended to reduce the compressive strength of mortars, the incorporation of GP (glass powder) led to significantly improve their strength especially at a replacement level of 40% by weight of sand [6].

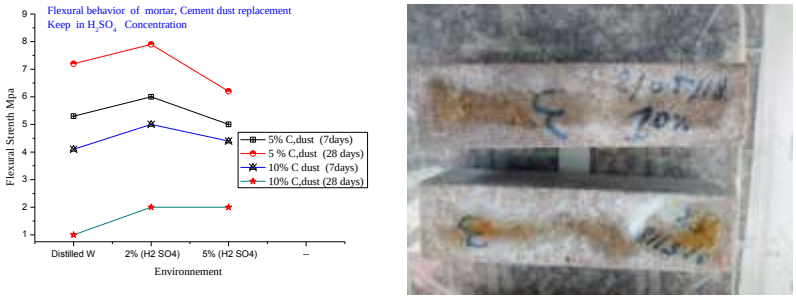

Figure 7: Mixtures and water absorption (3days in water) and (28days)

The current durability study at 28 days, 5% cement replacement level gave the greatest flexural strength in mortar. Similar trend was observed at the two percentages concentration of H_2SO_4 age of 28 days, however, 10% cement replacement gave the minor strength among the dust replaced in mortars.

However, the increase in concentration of H_2SO_4 was found significant compared to the distillate water.

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