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Effect of Ash Paper in Mechanical and Chemical Properties of Sand Concrete

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Keywords

Sand Concrete,
Compressive Strength,
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Paper Ash,
Substitution.

Abstract

This paper reports on the results of an investigation of utilization of ash paper in sand concrete as supplementary cementitious materials, the ash paper is used as a weight substitution in dune sand and it used with rates of 0 %, 0.1%, 0.2%, 0.3%, and Specifically, the mechanical properties as compressive and tensile strength and durability performance as the loss weight were measured. The results show that the incorporation of ash paper reduces the compressive strength and the flexural tensile strength. The use of waste plastic fibers indicates the good behavior to mortars in aggressive environment (H2SO4 acid).

1.Introduction

The use of waste paper from schools, libraries and shredders in concrete mixes to be used for construction projects is becoming a necessity to eliminate waste, in order to confront with the economic problems associated with waste disposal costs, especially the use of paper ash, in this paper. We are interested in the use of paper ash in the composition of sand concrete.

Many studies have been interested by the use of paper ash, Fauzi M.A. et al. (2016) were studied a comparative analysis of the experimental results novel properties of fresh and hardened concrete with recycled concrete aggregates (RCA) with different substitution of waste paper sludge ash (WPSA) as a partial substitute for cement [1.]. The findings demonstrated that the WPSA and RCA seems to contribute to the favourable concrete compressive strength.

Sumit A Balwaik and S P Raut (2011) studied the the use of paper-mill pulp in concrete formulations the cement has been replaced by waste paper sludge accordingly in the range of 5% to 20% by weight. As a result, the compressive, tensile and flexural strength increased up to 10% addition of waste paper pulp and further increased in waste paper pulp reduces the strengths gradually [2.].

B. Ahmadi and W. Al-Khaja (2000) studied the utilization of paper waste sludge obtained from a paper manufacturing industry, as a replacement to the mineral filler material in various concrete mixes. they prepared Five concrete mixes containing various contents of the waste, 0 (control mix), 3, 5, 8 and 10%, as a replacement to the fine sand with ratios of 1:3:6 by weight of cement, sand and aggregate. They found that as the amount of the waste increased the basic strengths, such as compressive strength was decreased. A maximum of 5% content of the waste as a replacement to the fine sand in concrete mix can be used successfully as construction materials [3.].
The incorporation of Waste paper sludge ash as a partial substitute of cement in natural aggregate concrete was investigated in several studies (Bai et al., 2003; Fava et al., 2011; Gailius and Laurikietyte, 2003; Kumar and Rani, 2016; Mozaffari et al., 2009). With recycled aggregate concrete, Fauzi et al. (2016) investigated 5%,10%, and 15% waste paper slag ash as a partial substitution for cement in recycled aggregate concrete containing only 25 or 50% recycled aggregate concrete. However, there is no available study to investigate the properties of recycled aggregate concrete with 100% coarse recycled aggregate concrete and PSA.
The recycled aggregate concrete containing waste paper slag ash may perform differently compared to natural aggregate concrete [4,5,6,7,8].

The main objective of the present study was to find a suitable application for utilizing waste paper ash in sand concrete.

2. Used materials

2.1. Sand The sand used is a sand of Oued Z'hour origin from Skikda region, Algeria, of granular class 0/2. Its grain size curve is presented in Figure 1. And its fineness modulus is about 2,8.

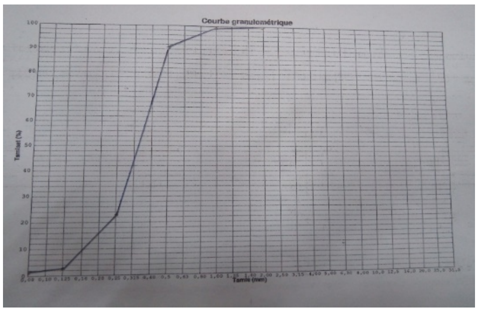

Figure 1. Grain size curve of sand

2.2. Cement

The cement used in this study was a class 42.5 CEM II from the Hdjar-Soud cement plant, Skikda, Algeria. with an absolute density of 3.22 g/cm3 and a Blaine specific surface of 3275 Cm2/g. Its chemical composition is presented in table 1.

Table 1. Chemical composition of cement.

Sio2 %	Al3 %	Fe2O3 %	Cao- %	So3 %	K2O %	Na2O %	Cl-%
20.16	4.54	5.54	62.97	2.66	0.34	0.18	0.001

2.3. Fines

The fines used in this study are fine limestone from the quarry of elkheroub, Constantine in the East of Algeria, the sieve passing 0.08mm is greater than 70% with an absolute density of 2.80 g/cm3.

2.4. Superplasticizer

The superplasticizer used is the Polyflow SR 5400-SOLU EST type, complying with the EN 934-2 standard. It is a super high water softener for concrete, is presented in the form of a light brown liquid with a density that varies from 1.07 ± 0.02.

2.5. Paper ash

In a large container the waste papers are put and ignited by fire until the paper has completely burned, the resulting ash has been brought in, to use as substitute in the cement. The chemical composition of the paper ash is presented in table2.

Table 2. Chemical composition of paper ash.

Sio2 %	AlO3 %	Fe2O3 %	So3 %	K2O %	Na2O %	Cl-%	P.		
2.33	0.55	0.72	-	-	-	-	41.99	51.51	0.97

3. Test and mixing procedures

The formulation of the mixtures was made by the method Sablocrete (Sablocrete 1994) with the fixed parameters of this study are, the dosage of adjuvant, the dosage in fines and the ratio W/C, and the parameter variable is the substitution rate of paper ash. Three specimens were used to determine the compressive and flexural tensile strength. Control concrete corresponds to 0% of substitution of paper ash was used as a reference concrete. Specimens produced from fresh concrete were remolded after 24 h and were then cured in water at 20 ± 2 °C until the date of the test.

4. Results and discussion

4.1 Workability

The tests are carried out on the sand concrete in the fresh state, the results of the workability of sand concrete are presented in the following figure 2.

From the table it can be seen that there is an influence of paper ash on the workability of sand concrete. The slump of sand concrete increases with increasing percentage of paper ash substitution, control sand concrete exhibits 5.8 cm slump while sand concrete with 0.3% paper ash shows 9 cm slump.

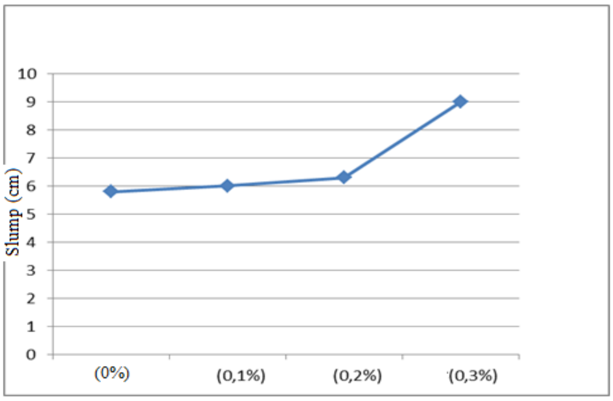

Figure 2. Variation of workability as a function of substitution rate

4.2 Density

The density results of fresh concrete for the different types of sand concrete are shown in the following figure:

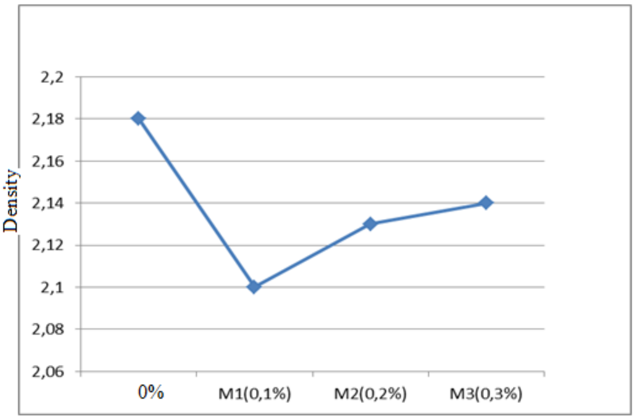

Figure 2. Variation of workability as a function of substitution rate

The density decreases with the increase of the percentage of substitution of paper ash in the sand concrete with 0.1%, then the density begins to increase slightly with the increase of the percentage of paper ash.

4.3 Compressive strength

This test is to follow the evolution of the compressive strength of sand concrete. The results of the 7 and 14 and 28 days crush tests of the different types of sand concrete are shown in the following figures.

At 7 days

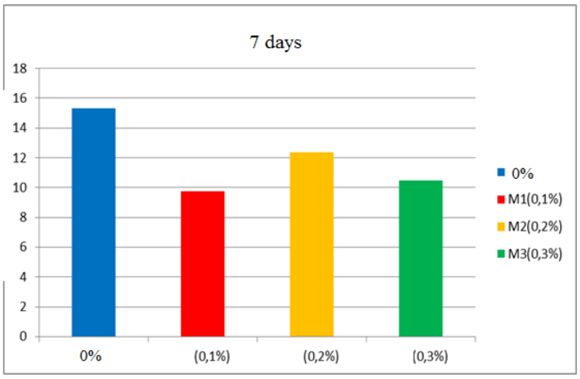

Figure 3. influence of substitution rate on compressive strength at 7 days

The best compressive strength corresponds to the control sand concrete. After the substitution, we notice a decrease in the compressive strength of sand concrete 0.1% then a slight increase in sand concrete 0.2%.

At 14 days

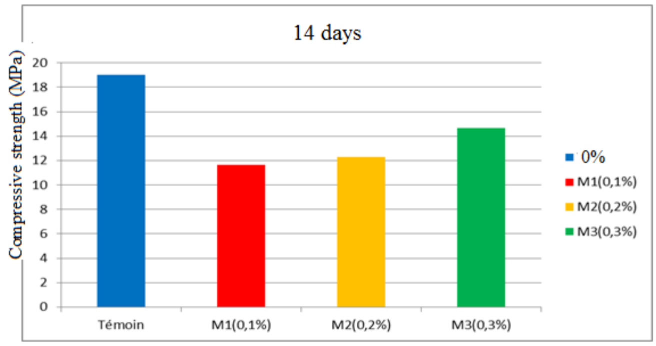

Figure 4. influence of substitution rate on compressive strength at 14 days

The best compressive strength corresponds to the control sand concrete. After the substitution, we can note a decrease in the compressive strength of sand concrete 0.1% and a slight increase in sand concrete with 0.2% and 0.3% successively.

At 28 days

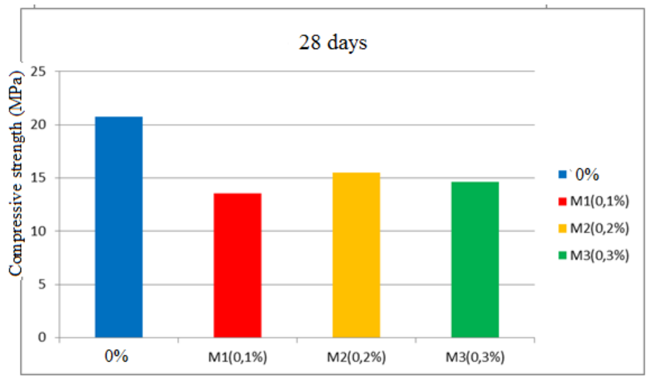

Figure 5. influence of substitution rate on compressive strength at 28 days

The variation of the compressive strength at 28 days was the same of 14 days, the best compressive strength corresponds to the control sand concrete. After the substitution, the compressive strength decrease, then a slight increase in sand concrete 0.2%.

The figure 6. shows the results of the influence of age on the evolution of the compressive strength of the substitution ratio.

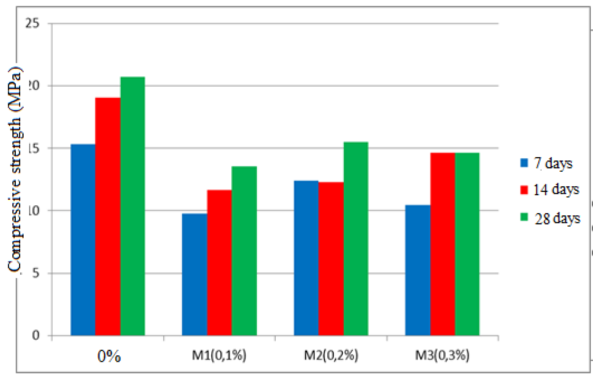

Figure 6. influence of age on the evolution of compressive strength as a function of the substitution rate

4.4 Flexural tensile strength

The results of the flexural tensile tests of the (4x 4x16 cm) specimens at 7, 14 and 28 days are presented in the figure 7

At 7 days

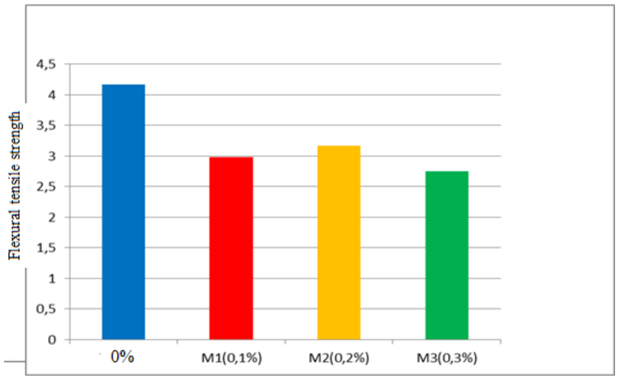

Figure 7. influence of the substitution rate on the flexural tensile strength at 7 days

The best flexural tensile strength corresponds to the control sand concrete. After the substitution, we noted a decrease in the bending tensile strength of sand concrete 0.1% and an increase in sand concrete 0.2%.

At 14 days

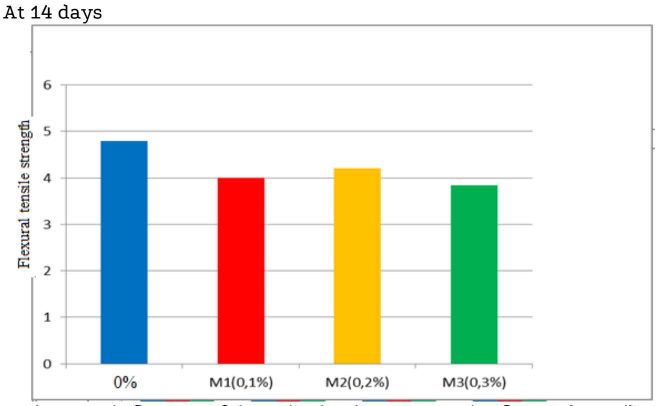

Figure 8. influence of the substitution rate on the flexural tensile strength at 14 days

The best flexural tensile strength corresponds to the control sand concrete. After the substitution, we observed a decrease in the compressive strength of sand concrete 0.1% then a slight increase in sand concrete 0.2%.

At 28 days

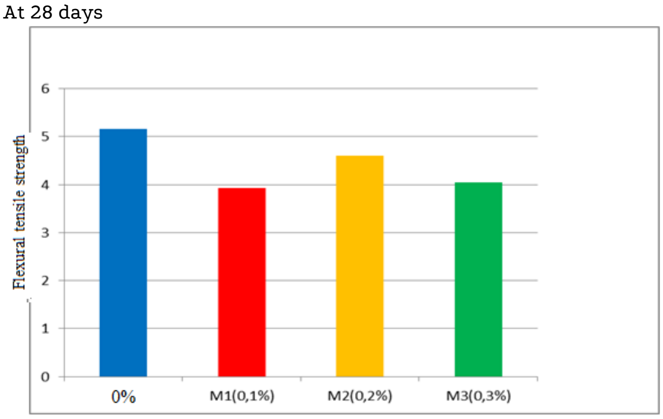

Figure 9. influence of the substitution rate on the flexural tensile strength at 28 days

The same observation of sand concrete in 7 and 14 days, the variation of compressive strength varies in the same way. The figure 10. shows the results of the influence of age on the evolution of the flexural tensile strength of the substitution ratio.

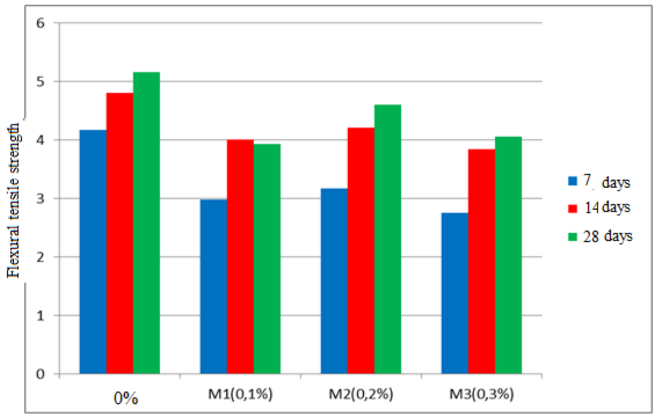

Figure 10. influence of age on the evolution of flexural tensile strength as a function of the substitution rate

5. Acid attack

After 28 days of water curing, the (5×5×5 cm) specimens were immersed in H2SO4 solutions, with 1% of concentration. The aggressive solutions were renewed every 28 days. After 7, 14 and 28 days, they were used to estimate the weight loss according to the standard ASTMC267-96 [18]. The results of weight loss of specimens are presented in the figure 11.

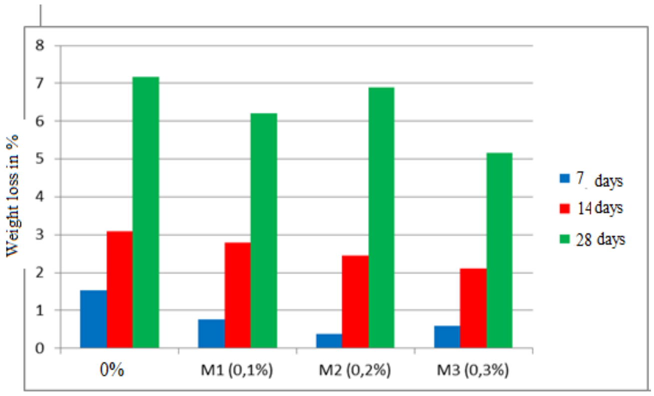

Figure 11. Weight loss depending on the period of immersion in 1% of (H2SO4) after 28 days in water

After 7 days of immersion in H2SO4, the sand concrete with 0.3% was presented the best chemical resistance when it presented the low weight loss.

The weight loss increase with the age of immersion for all specimens. When the mortars are attacked by sulfuric (VI) acid H2SO4, they react with the Portlandite Ca(OH)2 resulting from the hydration of the cement, which causes the formation of gypsum and The process is described by the following chemical reactions:

$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4{\cdot}2H_2O$ (1)

$3CaSO_4 + 3CaO{\cdot}Al_2O_3{\cdot}6H_2O + 26H_2O \rightarrow 3CaO{\cdot}Al_2O_3{\cdot}3CaSO_4{\cdot}32H_2O$ (2)

6. Conclusion

The paper ash was used as weight substitution in the cement, according to the results of the various tests it can be concluded that:

The introduction of paper ash affects fresh sand concrete properties, increasing workability and decreasing density and increasing porosity.

Paper ash affects hardened sand concrete, it decreases compressive strength, flexural tensile strength, negatively the substitution of paper ash enhances the chemical resistance to sulfuric acid.

Declaration of Conflict of Interests

The authors declarethat there is no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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