Mechanical properties of corncob ash mortar

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ABSTRACT

In the last decade, the use of supplementary cementing materials has become an integral part of performance concrete and mortar. This can be natural materials. This paper describes on analyzing the effects of use of corncob ash in the mechanical properties of mortar. The purpose of this study was to use of cement mortar reinforced by the various percentages of corncob ash (CCA) (0, 2, 4 and 6%) as a partial replacement for cement. The samples were kept in the curing pool for 28 days of curing. After 28 days, samples taken from the curing pool were subjected to compressive strength test and flexural strength test. According to the results of the experiment, it was determined how the corncob ash affected the mortar strength.

Keywords *- Cement, corncob ash, mortar, strength*

I. INTRODUCTION

Cement, a major constituent of concrete, is pivotal to development and is produced in virtually all countries [1, 2]. One ton of concrete on average is produced every year for every human being in the world [3]. Utilization of Partial Cement Replacements reduces solid waste, cuts on greenhouse gas emissions and conserves existing natural resources, thereby enhancing sustainability as well as improving the properties of concrete and mortar [4-6].

Today, pozzolan materials plays an important role in concrete. Wastes of industries and constructions which have pozzolanic or cementitious characteristic, not only can reduce environmental pollution and energy consumption of construction industry [7-9].

It is important to reduce this impact through the replacement cement with artificial clay, agricultural waste and other wastes. Supplementary cementitious materials are generally by-products from natural materials. They may or may not be further processed for use in concrete [10].

Agricultural by product pozzolan have been used in the manufacture and blended cements [11]. Research indicates that agricultural by products that are rich in amorphous silica can be used as partial replacement to cement [12 – 14].

This paper research is to investigate properties of cement mortar incorporating with or without corncob ash.

Table 1. Chemical analysis of cement

Chemical composition, %								
SiO_2	CaO	Al_2O_3	Fe_2O_3	MgO	K_2O	SO_3	Na_2O	LOI
19.88	62.62	5.23	3.60	0.85	0.75	3.23	0.03	1.00

II. MATERIALS AND METHODS

2.1. Materials

2.1.1. Sand

Rilem sand produced in Limak Çimento Sanayi A.S according to Rilem-Cembureau Standard. The grading of CEN sand is given in Table 1.

Table 1: The Grading of CEN Sand

Sieve Size (mm)	2.00	1.60	1.00	0.50	0.16	0.08
Cumulative Percentage (%)	0	7 ± 5	33 ± 5	67 ± 5	87 ± 5	99 ± 1

2.1.2. Cement

The cement used in all the mixes was CEM II 42.5 R. Its gravity was about 3.14 g/cm^3. The chemical analysis and properties of the cement are given in Table 1 and Table 2, respectively.

Table 2. The properties of cement

	PROPERTIES		UNIT	Cement
PHYSICAL PROPERTIES	Specific Gravity		g/cm^3	3.16
	Specific Surface Area		cm^2/g	3550
	Initial setting time		min	119
	Final setting time		min	170
	Volume expansion		mm	1
	Fineness 45 µm		%	3.1
	Fineness 90 µm		%	0.2
MECHANICAL PROPERTIES	Compressive Strength	2 days	MPa	31.4
		7 days		43.8
		28 days		60.1

2.1.3. Corncob ash

Corncob used in this study was provided from Tekirdağ, Turkey. Corncobs were burnt in the open air until they turned to ashes.

2.2. Mix Methods

The mortars with the corncob ash was varied of 2, 4 and 6% by weight of the binder and applied in TS EN 196-1 [15]. Mix amounts of the mortars are shown in Table 3. Firstly, water, cement and corncob ash were added to the

mixer and mixed for 30 s then sand was added and mixed for 30 s. The mixer was regulated to high speed and mixed for 30 s. The mortars were filled into the molds then mortar samples were placed into 40x40x160 mm prismatic molds. After 24 h, samples were cured in water until the 28 days. Water/binder ratio is constant at 0.50.

Table 3. Mix proportions of mortars

Name	Water, g	Cement, g	Sand, g	Corncob ash
E0	225	450	1350	0
E2	225	450	1323	27
E4	225	450	1296	54
E6	225	450	1269	81

2.3. Experiment method

2.3.1. Compressive strength

The compressive strength were conducted according to TS EN 196-1. The one broken parts of the specimen retained after tests were used. The *tests* were *done* on cured specimens at *28* days. Equation 1 below was used to determine compressive strength:

$$Rc = Fc / 1600 \quad \text{.....(1)}$$

Rc is the compressive strength, MPa
Fc is the is the load of failure, N.
1600 is the area of the platens (= 40 mm x 40 mm), mm^2

2.3.2. Flexural strength

The flexural test of the specimens was tested in accordance with TS EN 196-1. In order to determine the flexural strength of the mortars 40x40x160 mm specimens were used and were tested at 28 days. The flexural strength test in accordance with TS EN 196-1 [15]. using equation 2 below:

$$Rf = (1.5 \times F \times \ell) / b^3 \quad \text{.....(2)}$$

In the equations above Rf is the flexural strength, MPa
F is the load of failure, N
b is the side of the prism, mm
ℓ is the distance, mm.

III. RESULTS AND DISCUSSIONS

3.1. Flexural Strength

This study was conducted on the cement mortar blended by the different percentages of corncob ash (0, 2, 4 & 6%) as a partial replacement for cement. Figure 1 show the result for the flexural strength mortars at 28 days respectively made with corncob ash. This figure shows the increase in the strength with an increasing amount of ash. The highest flexural strength results was found at 2% at 28 days. Based on Figure 1 by adding 2, 4, 6% corncob ash in mortar increases the flexural strength as compared to 0% corncob ash.

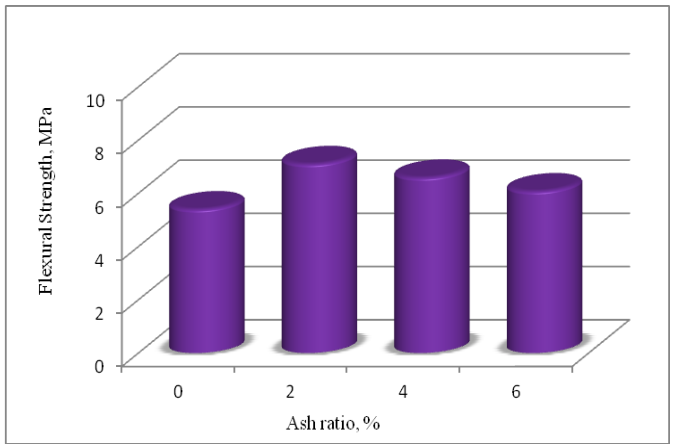

Figure 1. Flexural strength at 28 days

3.2. Compressive Strength

The compressive strength results are seen in Figure 2. The highest compressive strength for the population was found at 2 and 4% at 28 days. Apart from the 6% replacement, all other replacements realized compressive strengths of above the 32 MPa at 28 days. It can be shown in Figure 2 that the addition of 6% ash lowered the strength compared 0%. The highest compressive strength results was found at 4%.

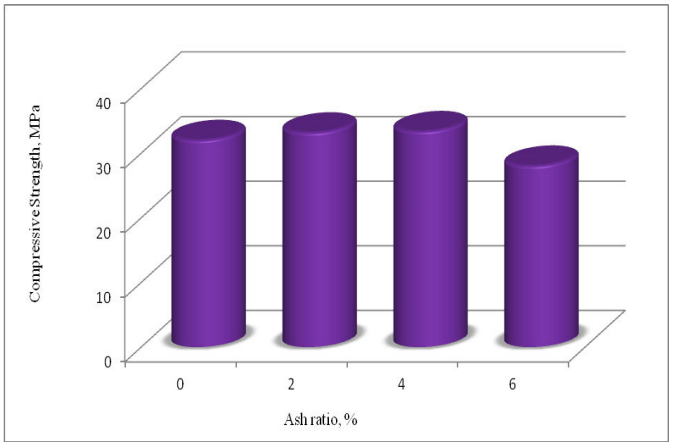

Figure 2. Compressive strength at 28 days

IV. CONCLUSION

This paper describes on analyzing the effects of use of corncob ash in the mechanical properties of mortar. The following conclusions are obtained from the overall test results.

- Replacing a portion of corncob ash with up to 4% found to increase the compressive strength of mortar.
- The highest compressive strength for the population was found at 2 and 4% at 28 days.
- The highest flexural strength results was found at 2% at 28 days.

These results show that corncob ash can be used as a partial cement replacement to decrease on the cost of cement and its impacts on the environment.

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