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EXPERIMENTAL STUDY AND SEM ANALYSIS ON MORTAR CUBE WITH WOOD ASH FOR PARTIAL REPLACEENT OF CEMENT

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Abstract:

In the present view, several buildings are constructed ranging from ordinary residential building to sky - scrap structures. Invariably in all the structures, mortar plays a vital role in construction. Generally mortar is mixture of cement, fine aggregate, water and different type of admixtures used depends upon the situation. The cost of cement is increasing progressively day to day. In consequently cost of the building is also being increased. Wood ash does not make any pollution and eco – friendly for green building construction. This material is easily get more from burning of wood in home and industries, there by the cost of material too be reduced. Therefore, it has planned to conduct experiment on mortar in which the cement is partially replaced by wood ash. SEM Analysis is also carried out in mortar mix for observing bond between cement and wood ash.

Keywords: *Concrete; Compressive Strength; Ordinary Portland Cement; Wood Ash.*

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1. Introduction

Mortar is a workable paste used to bind building blocks such as stones, bricks and concrete masonry work units together, fill and seal the irregular gaps between them, and sometimes add decorative colours of patterns in masonry wall. In its broadest sense mortar includes pitch, asphalt and soft mud or clay, such as used between mud bricks. Cement mortar becomes hard when it cures, resulting in a rigid aggregate structures; however the mortar is intended to be weaker than the building blocks and the sacrificial element in the masonry, because the mortar is less expensive to repair than the building blocks. Mortars are typically made from a mixture of sand, a binder since the early 20th century Portland cement but the ancient binder lime mortar is still used in some new construction. Lime and gypsum in the form of plaster of Paris are used particularly in the repair and repointing of buildings and structures because it is important in the repair materials. The type and ratio of repair mortar is determined by a mortar analysis.

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Pozzolanic mortar is a lime based mortar, but is made with an additive of volcanic ash that allows it to be hardened under water.

2. Materials Used

Cement

Cement is fine, grey powder. It is mixed with water and sand to make mortar. In the present work OPC cement of 43 grades were used for experimental study for casting cubes for all concrete and mortar mixes. The cement was uniform colour i.e. grey with light greenish shade and was free from any hard lumps. The Specific gravity of the cement is 3.1. The fineness of the cement is 3.25%.

Fine Aggregate

Usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregate. Sieve analysis of the fine aggregate was carried out in the laboratory. The sand was first sieved through 4.75mm sieve to remove any particle greater than 4.75 mm sieve and then washed to remove the dust. The specific gravity of fine aggregate is 2.63. But the normal value of specific gravity of sand is 2.63. Low value of specific gravity of 2 and below would suggest the presence of organic matter or porous particles in sand. Sand containing heavy substances such as iron may have specific gravity values above 3 .The fineness modulus of aggregate is 2.94 which is said to be strong enough to use.

Water

Water used for mixing and curing shall be clean and free from Injurious amount oils, acids, alkalis, salts, sugar, organic materials other substance that may be deleterious to concrete or steel. Portable water is generally considered satisfactory for mixing and curing of mortar or concrete.

Wood Ash

Wood ash is residue powder left after the combustion of wood, such as burning wood in a home fireplace or an industrial power plant. The wood ash sample passing through 90µ sieve is taken for testing. The Fineness of wood ash is 4.33% and the Specific gravity of wood ash is 2. The type of wood, combustion temperature and combustion time plays a vital role in the quantity of ash produced and its chemical composition as shown in Table 1 and wood ash as shown in Figure 1.

Figure 1: Wood ash

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Table 1: Chemical Compositions of Wood Ash

Oxide composition	**Wood Ash**
Sio_2	46.05
Cao	18.23
Fe_2O_3	8.12
Al_2O_3	7.55
MgO	2.1
K_2O	4.2
Na_2O	1.5
TiO_2	0.1
MnO	2.85
P_2O_5	1.7
SO_3	1.4
LOI	6.2

3. Mix Proportion

The mix proportioning of conventional mortar includes the proportioning of the various ingredients like cement, fine aggregate, wood ash. In this experimental work mix ratio 1:3 is used. The total quantity of concrete required for the entire numbers of mortar are determined. From which, the quantity of wood ash and fine aggregate are determined by parts excluding cement. From that quantity, the weight of ingredients is determined by multiplying with its weight. The corresponding water content is water cement ratio. Following Tables 2 gives the mix proportion of mortar cube the Quantities of Materials required for various Mixes.

Table 2: Quantities of Materials required for various Mixes of Mortar cube

Mixing Details	**Cement (kg)**	**Fine aggregate (kg)**	**Wood ash (kg)**
R(1:3:0.49)	1.2	3.6	-
WA_1 (R + 10% Wood ash – 10% Cement)	1.08	3.6	0.12
WA_2(R + 20% Wood ash – 20% Cement)	0.96	3.6	0.24
WA_3(R + 30% Wood ash – 30% Cement)	0.84	3.6	0.36

4. Result and Discussions

4.1. Compressive Strength Test

Compression test is the most common conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of mortar are qualitatively related to its compressive strength. The cube specimen is the size 70mm X 70mm X 70mm.

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Remove cube from the curing tank. Wipe off surface water and frit with a damp cloth. Wipe test machine platens with dry cloth. Place the test cube centrally on the test cube facing towards you. Lower the top pattern on to the cube and ensure a uniform seating by section. Gently rotating the platen as it is brought to bear on the cube. Make sure that test machine is set to the correct loading and pointers are read as zero. Apply the load without shock and continuously. Record the maximum load the cube can sustain. Compressive strength can be calculated by using the following formula,

Compressive strength (σ) = P_{max} / A

Where,

σ = Compressive strength in N/mm^2

P_{max} = Maximum load that cube sustained

A = Cross sectional area of the cube

Compressive strength test result at 7days and 28 days curing values are presented in Table 3. Compressive strength of reference concrete mix 21.08 N/mm^2 and 26.18 N/mm^2 at 7 days and 28 days, it is observed that an increasing of percentage of wood ash, compressive strength goes on increasing up to 10% beyond that strength goes on decreasing. Hence concluded that is no use adding wood ash beyond 10% of cement. Figure 2 shows variation of compressive strength at 7 days and 28 days curing.

Table 3: Compressive strength test result at 7days and 28 days curing values

Mix	Compressive Load (KN)						Compressive strength (N/mm^2)		% of improvement	
	Specimen I		Specimen II		Specimen III					
	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days
R	115	130	95	95	100	135	21.08	26.18	0	0
WA_1	105	103	125	125	110	155	23.12	26.87	10	3
WA_2	60	90	65	65	70	85	13.26	18.7	-37	-28
WA_3	50	70	45	45	45	80	9.52	15.64	-54	-40

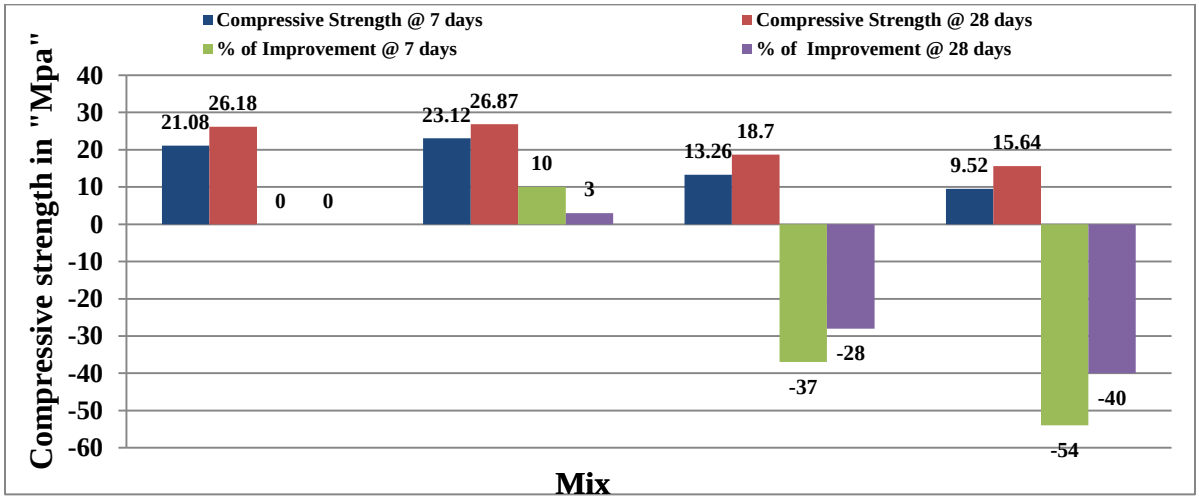

Figure 2: Effect of wood ash on compressive strength after 7days and 28 days curing

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4.2. Scanning Electron Microscopy (SEM) Analysis

Scanning electron microscopy (SEM) is a powerful technique in the examination of materials. The SEM analysis is used to find out micro structures of mortar and textural & compositional inter relationships of mortar components. It also used for find out the effect of w/c ratio and the addition of mineral admixtures.

SEM micrographs were recorded with VEGA3 TE scanning electron microscope with a maximum accelerating voltage of 20Kv at high vacuum mode. SEM photographs are presented for reference mix and WA_1 mix at 2, 5, 10, 20 µm to show particles distribution in mortar cube after 7 days and 28 days curing as in figure 3 and 4. From SEM photograph one can easily understand how bonding occurred an cement with sand and cement with wood ash.

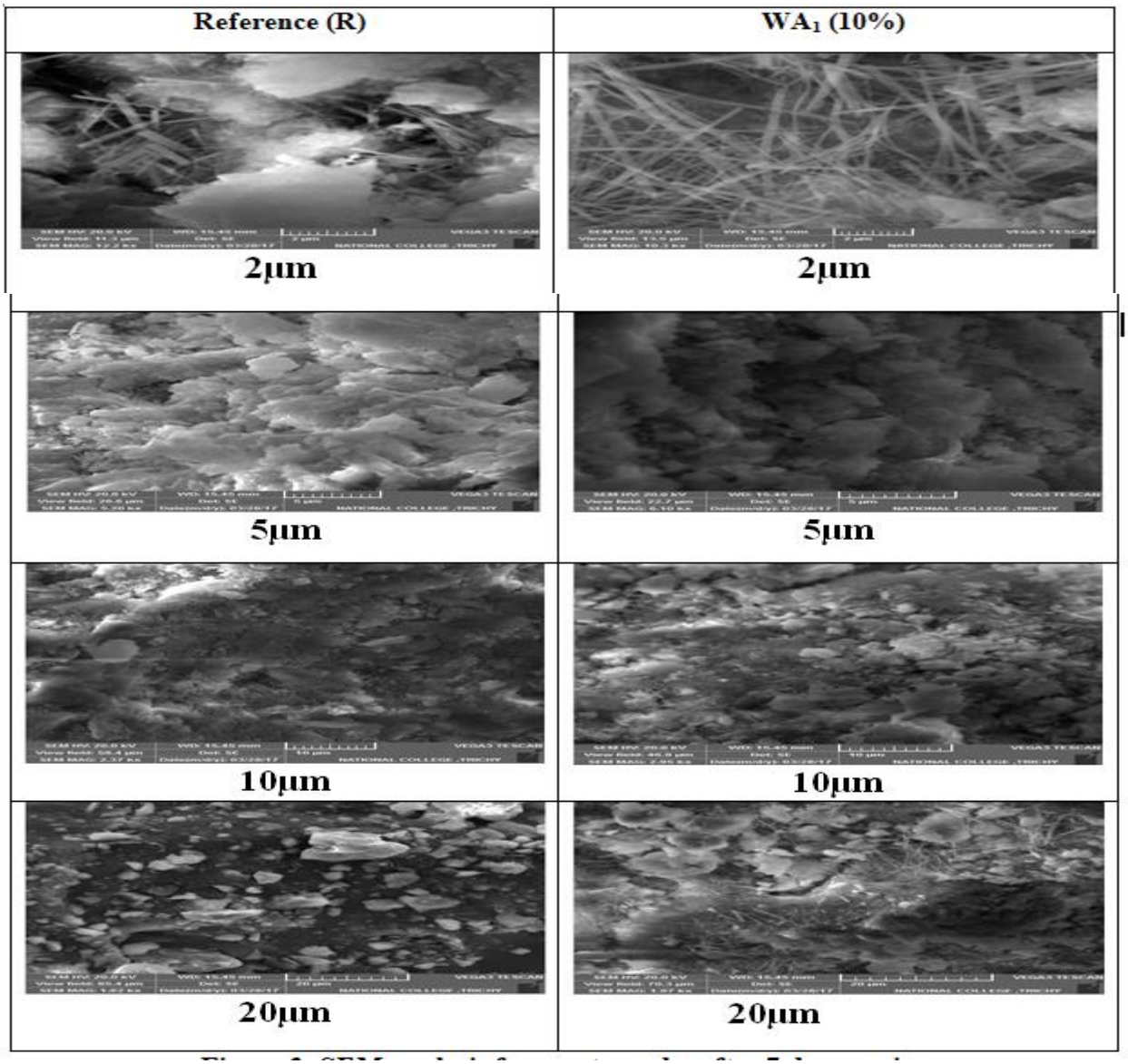

Figure 3: SEM analysis for mortar cube after 7 days curing

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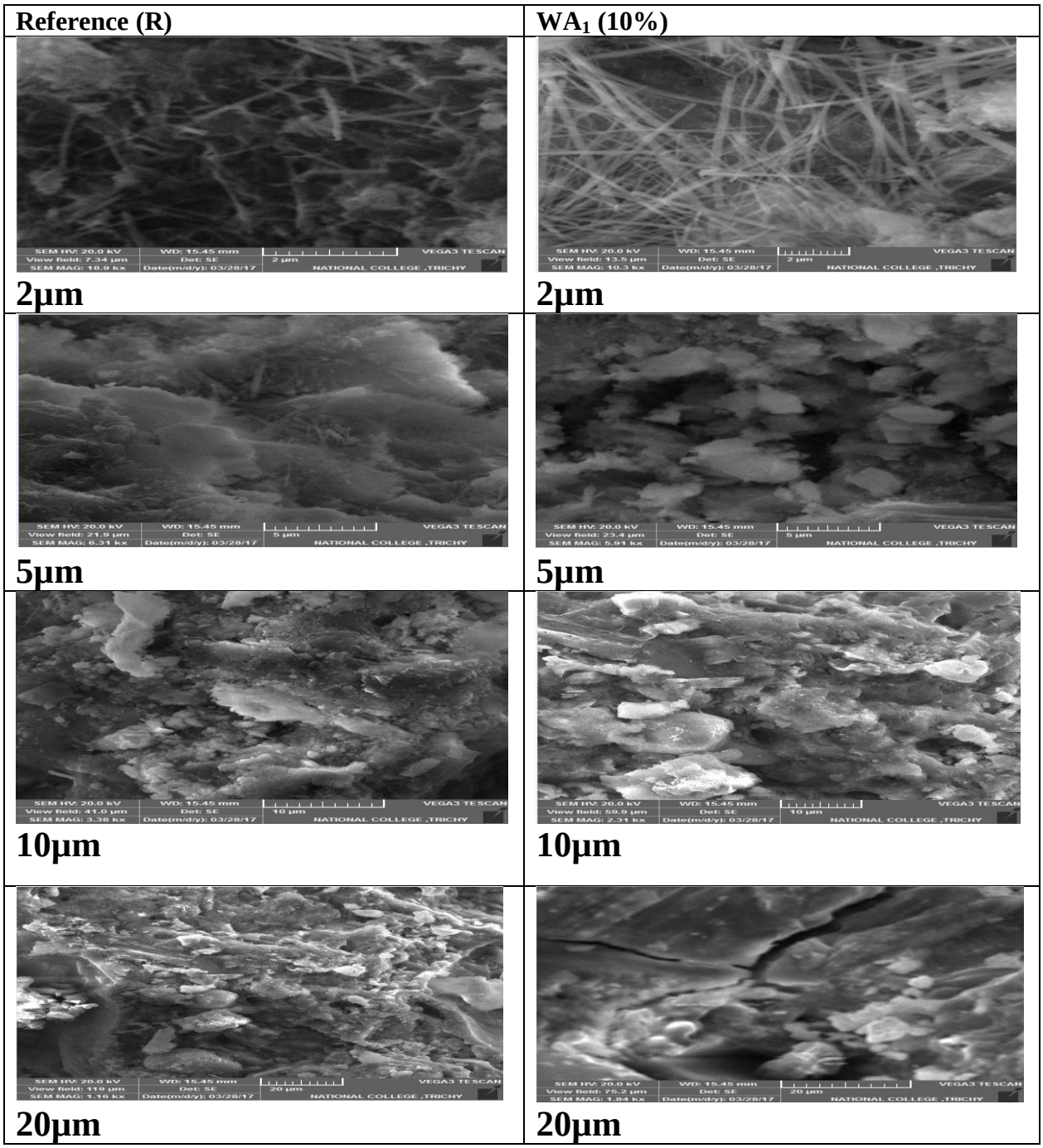

Figure 4: SEM analysis for mortar cube after 28 days curing

5. Conclusions and Recommendations

Based on the test results obtained from the experimental program of this work the following major conclusions are arrived from compressive strength test and SEM analysis.

From the experimental test results, the compressive strength for after 7 days and 28 days curing of mortar mix having 10% wood ash (WA_1 mix) has the highest strength of 23.12 Mpa

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and 26.87 Mpa, and its percentage improvement is 10 over reference mix. 3 over reference mix. Consequently, it is concluded that concrete mix having 10% replacement of cement by wood ash (WA_1 mix) is better mix and has the highest compressive strength for both 7days and 28days curing test results.

SEM photographs are presented for reference mix and WA_1 mix at 2, 5, 10, 20 µm to show particles distribution in mortar cube after 7 days and 28 days curing. From SEM photograph one can easily understand how bonding occurred an cement with sand and cement with wood ash.

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