

SEM and EDX Analysis of Waste Paper Sludge Ash and Cement

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ABSTRACT

In Sivakasi, India, large volume of paper sludge is discharging from paper mill daily. These discarded paper sludge is clogging the pores of the land, when it is disposed over the land and thus creating the environmental pollution and illness to the peoples. Therefore, it is planned to examine the possibilities to utilize the waste paper sludge ash for the manufacturing of concrete in the construction industries for the replacement of cement. In this work, it is planned to perform the SEM and EDX analysis for the paper sludge ash obtained from paper mill. It contains.

On the basis of the results obtained by performing the SEM and EDX analysis, it was observed that the size of the waste paper sludge ash is less than 50μ and the waste paper sludge ash contains large amount of oxides of calcium, silica and aluminium. The components and their proportions of the minerals of the waste paper sludge ash is very resembles with the cement. Hence, it is suggested that the waste paper sludge ash could be replaced for the partial replacement of cement for making concrete. Also, the size of the waste paper sludge ash is less than size of the cement particles and therefore it helps to improve the durability performance of concrete.

KEYWORDS: Waste Paper Sludge, Cement, SEM, EDX

1. INTRODUCTION

In Sivakasi, India, the paper industries recycle large amount of Waste Paper Sludge (WPS) in the production of paper process and making new paper using the recycled waste. The WPS discharges on the land after recycled in the industries. The WPS disposed over the land is producing unhealthy environment, causing air pollution and land pollution. Sometimes the WPS has clogged the pores of soil media in the underground and thus reducing the percolation of water in to ground through the pores. Therefore it is necessary to dispose the WPS in proper manner.

The recycling process of paper produces ash which has potential useful application in construction. The WPS contains cementitious properties. Hence the waste paper sludge ash is used as a construction material [1-3]. While comparing with PC, the WPS ash shows different hydration and setting behavior [4]. The WPS ash contains considerable amount of aluminosiliceous materials, majority of which appear to be combined with calcium [5]. The cement industries are doing research works with new sustainable development policies by using the by-products such as Fly ash, Silica fume, Blast furnace slag, rice husk and quarry dust etc. as active additions in the manufacturing of blended cement. Furthermost, the utilization of by-products provides the benefits of scientific, technical and economic nature such as improvement in the mechanical performance and durability of cement [6]. In this context, it is proposed to obtain active additions from the industrial by-products [7] other than those traditionally used in the cement industries. WPS is a cementitious material in which some constituents hydrate faster than others. The free lime in the WSA reacts

with water immediately upon soaking and provides a highly alkaline pore solution, which then results in the release of more reactive phases such as Al_2O_3 and SiO_2 into the system [8].

Therefore, it is planned to examine the mineral size and components using the SEM and EDX analysis.

2. EXPERIMENTAL SET UP:

2.1. Experimental set up of SEM:

Scanning Electron Microscopy (SEM) analysis was performed by a JEOL JSM- 6360 electron microscope. For SEM imaging to visualize the size and shape of the WPS Ash and Cement samples was placed on a carbon strip attached to a SEM brass, extra ash and cement was removed using blotting paper and then allowed to dry by putting it under a mercury lamp for 5 min.

2.2. Experimental set up of EDX

The elemental compositions of WPS Ash and Cement were obtained by using Energy Dispersive X-ray (EDX) analysis (JEOL JSM-6360) at variable pressure scanning electron microscope equipped with INCA X-sight Oxford instrument facility, at an acceleration voltage of 20 keV.

3. SEM AND EDX ANALYSIS:

3.1. SEM and EDX analysis of WPS ash sample:

Figure 1 shows, the SEM image of the WPS Ash. The overall morphological shapes of the WPS Ash are spherical and rectangular at higher magnification. The average sizes of the gold nanoparticles were 1-50 μ m.

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EDX analysis of WPS Ash profile Figure 2 shows strong signal for elemental Ca other signals of chemicals (Si, Al, P, I and Sb). The WPS Ash crystallites display an optical absorption band peaking at 2.15 keV. EDX analysis suggested that many chemicals were absorbed on the surface of the WPS Ash and are strongly responsible for the stability of the synthesized WPS Ash. The Table 1 shows the mineral components of the WPS Ash sample.

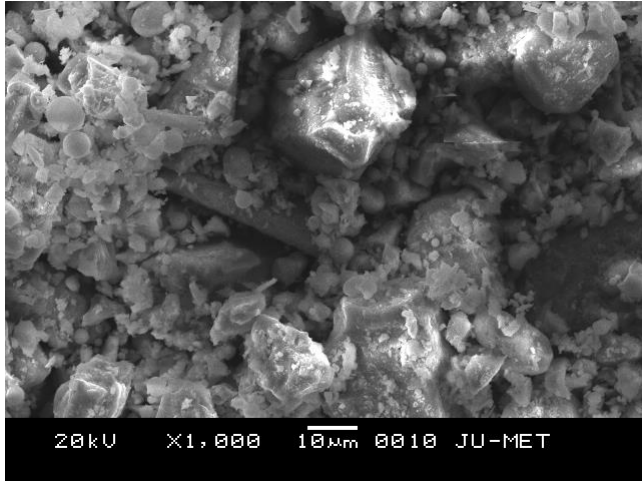


Fig.1: SEM image of the WPS Ash Sample.

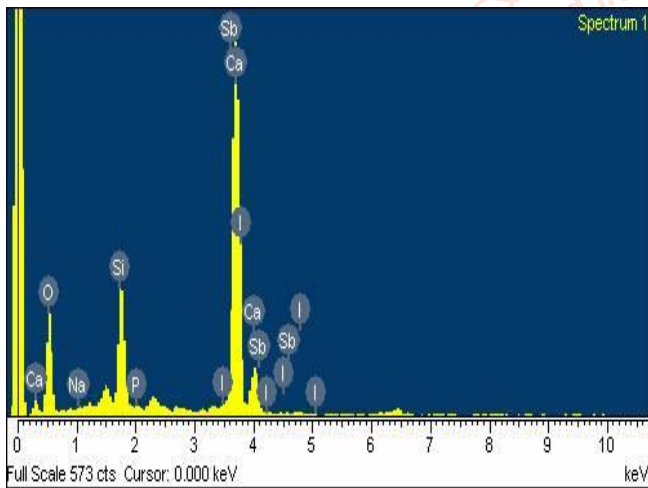


Fig.2: EDX analysis of WPS Ash Sample.

Table 1: Mineral components of the WPS Ash Sample

Sl. No.	Element	Weight (%)	Atomic (%)
1	Oxides (O)	40.87	66.15
2	Aluminium (Al)	02.12	02.04
3	Silicon (Si)	09.03	08.33
4	Phosphorus (P)	00.07	00.06
5	Calcium (Ca)	30.63	19.79
6	Antimony (Sb)	11.91	02.53
7	Iodine (I)	05.37	01.10
Total		100.00	100.00

3.2. SEM and EDX analysis of cement sample:

Figure 3 shows, the SEM image of the Cement. The overall morphological shapes of the Cement are spherical at higher magnification. The average sizes of the gold nanoparticles were 1-100µm.

EDX analysis of Cement profile Figure 4 shows strong signal for elemental Ca other signals of chemicals (Si, Na, Al, S, K, Fe and Sb). The Cement crystallites display an optical absorption band peaking at 2.15 keV. EDX analysis suggested

that many chemicals were absorbed on the surface of the Cement and are strongly responsible for the stability of the synthesized Cement. The Table 2 shows the mineral components of the Cement sample.

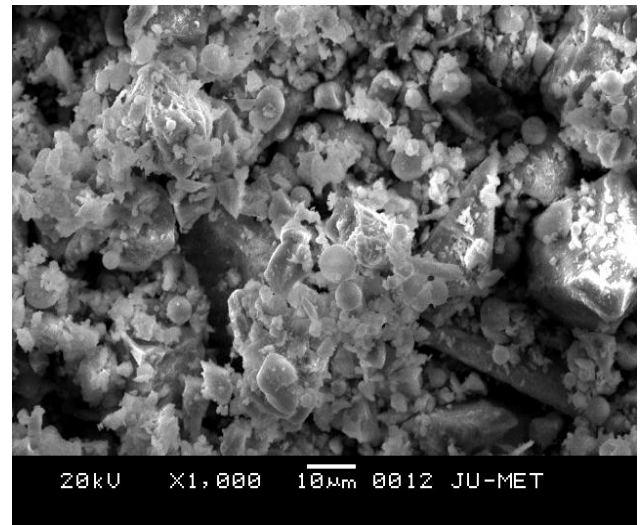


Fig.3: SEM image of the Cement Sample.

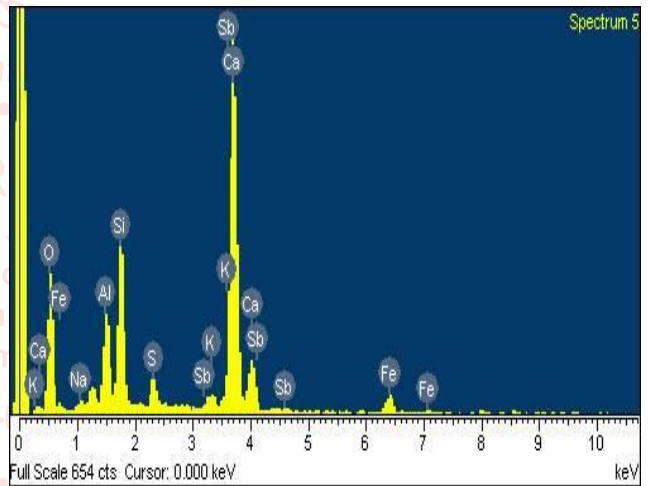


Fig.4: EDX analysis of Cement sample.

Table 2: Mineral components of the Cement Sample

Sl. No.	Element	Weight (%)	Atomic (%)
1	Oxides (O)	38.96	61.57
2	Sodium (Na)	00.55	00.61
3	Aluminium (Al)	04.76	04.46
4	Silicon (Si)	08.45	07.60
5	Sulphur (S)	01.81	01.43
6	Potassium (K)	00.87	00.56
7	Calcium (Ca)	31.66	19.97
8	Iron (Fe)	04.49	02.04
9	Antimony (Sb)	08.46	01.76
Total		100.00	100.00

4. RESULTS AND DISCUSSIONS:

The following discussions were made after conducted the elemental analysis of the waste paper sludge ash and cement using SEM and EDX.

1. From SEM analyse, it was observed that the size of the waste paper sludge ash is varying from 1µm - 50µm, where as the the size of cement particle is varying from 1µm - 100µm. From this SEM analysis, it was observed that the size of the waste paper sludge ash is very small than cement particle. The smaller size particle of waste

paper sludge ash helps to improve the durability performance of concrete.

2. From EDX analyse, it was observed that the paper sludge ash contains strong signal for elemental signals of oxides

of calcium, silicon, aluminium and antimony. The table 3 shows that majority of the elemental proportions which is contains in the waste paper sludge ash were very close to the cement particle (OPC).

Table 3: Comparison of Mineral components of the WPS ash and Cement Sample

Sl. No.	Element	WPS Ash		Cement (OPC)	
		Weight (%)	Atomic (%)	Weight (%)	Atomic (%)
1	Oxides (O)	40.87	66.15	38.96	61.57
2	Sodium (Na)	-	-	00.55	00.61
3	Aluminium (Al)	02.12	02.04	04.76	04.46
4	Silicon (Si)	09.03	08.33	08.45	07.60
5	Sulphur (S)	-	-	01.81	01.43
6	Phosphorus (P)	00.07	00.06	-	-
7	Potassium (K)	-	-	00.87	00.56
8	Calcium (Ca)	30.63	19.79	31.66	19.97
9	Iron (Fe)	-	-	04.49	02.04
10	Antimony (Sb)	11.91	02.53	08.46	01.76
11	Iodine (I)	05.37	01.10	-	-
Total		100.00	100.00	100.00	100.00

5. CONCLUSION:

- A. The size of the mineral admixtures available in the Paper Sludge ash sample is very finer than the size of the mineral particles of the Cement and hence it is observed that the finer particles of the paper sludge ash decrease the pores of the concrete matrix and thus increasing the durability performance.
- B. The paper sludge ash contains large amount Oxides of Silicon and Calcium. It is maintaining the strength carrying capacity of the Cement Mortar containing Paper sludge. Hence, the waste paper sludge ash materials could be utilized as pozzolanic materials for replacing the cement for making concrete.

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