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Experimental Studies on Solidification and Stabilization of Tannery Sludge

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Abstract: ***Solidification / stabilization the primary object is the treatability study and verify treatment formulation of each of the waste type identification, so that the treated material to meet out the disposal requirements on site. The heavy toxic metals present in tannery sludge can mobilized in the environment in many forms and cause effect to the ecosystem and human health. The detailed investigation of metals in sludge gives various information to their toxicity in the surroundings and determines their suitability for land disposal. Properties of moisture content, volatile solids, Mn, Cd, Zn, Fe, Cr, N, Cu and Cl in tannery sludge were determined for their toxicity level. Solidification studies were carried out using OPC with tannery sludge, and fly ash to solidify and stabilize. The stabilization were carried out using lime 10%, 20%, 30%, 40% and 50% with tannery sludge. The in our work we selecting of six mix properties for tannery sludge were prepared for compressive strength and leachate test. All the test specifiments were air curved and tested for their 3 days, 7 days, 14 days and 28 days compressive strength. The experimental studies output results should a considerable amount of compressive strength of those specimens with fly ash, cement. All the specimens to achieve and the target compressive strength of 0.3 Mpa (as per our code) required for landfills. Lime was found to be one of the good materials for in stabilizify the heavy metal sludge. The optimum mix ratio was formed to be finding having 5 % of fly ash 5 % of cement and 90 % of sludge. Toxi chemical leaching procedure (TCLP) test indicated leaching property stabilized sludge was minimizing to very low level.***

Keywords: Solidification / stabilization, pozzolonic activity, sanitary fill, leaching test, chromium, lime.

I. INTRODUCTION

Application of sludge to land is defined as the spreading of sludge on just below the soil surface. The land application is designed with the objective of providing further sludge treatment. Sludge may be applied to 1. Forest land 2. Disturbed land 3. Dedicated landposal sites. Large number of industries produces waste containing hazardous metals such as Zinc, Chromium, Cadmium, Lead, Mercury (or) copper. These metals are finding in sludge casing environmental problems and are hazardous to living things. Sludge sample obtained from Common effluent treatment plant (CETP) M/s Vani - Tech / Vaniyampadi / Vellore district/Tamilnadu/India must be stabilized and sludge Solidified prior to disposal by secured landfills. Main object of S/S are to convert the heavy metals to immobile phase and for easy of handling. The immobile phase will also reduce the hazardous effects on the environment. Cementations solidification is commonly practiced. So the toxic metals are well combined in cement with small amount leached out in leaching test. This investigation aims to identify how chromium was kept within cement, fly ash, lime + waste mixes. The results will indicate strength of the mixes for safe land fill. A lot of investigations have been carried out on the S/S of heavy metals sludge and other toxic waste using OPC, Chemicals, Lime and Coal plant fly ash. Research proves on the use of fly ash as a cementations binder and on the use of cement to stabilize fly ash. Our experimental focused on the formulation of an adequate binding mix comprising cement and fly ash in solidifying, tannery sludge satisfying. In this method fly ash also added to the sludge, otherwise would also be deposed of at landfills.

II. MATERIAL & METHODS

Heavy metal laden sludge was collected from different points of sludge drying bed of Common effluent treatment plant (CETP) / Vaniyampadi. The additives used for this research were cement, sand, fly ash and lime. The fly ash collected from Neively lignite corporation, Neively, Tamil Nadu, India. Fly ash is cementations coal combustion by product. The fly ash is classified according to ASTM C – 618, Class F and Class C fly ash. The main difference between these two classes is the quantity of Ca, Si, Al and Iron content.

Table 2.1 Typical analysis of fly ash

Characteristics	Value
Specific Gravity	1.86
Bulk Density (kg/m^3)	400
Colour	Gray

Table 2.2 Chemical Analysis of Fly Ash

Oxide	Percentage of Content
Cao	13.10
Sio_2	40.66
Al_2O_3	23.16
Fe_2O_3	12.30
MgO	4.00
K_2O	0.041
Na_2O	0.02
So_3	0.31
Loss on ignition	1.98

Table 2.3 Chemical Analysis of OPC

Oxide	Percentage of Content
Cao	61.42
SiO_2	18.62
Al_2O_3	4.75
Fe_2O_3	3.02
MgO	3.21
K_2O	1.42
Na_2O	1.51
So_3	2.2
Loss on ignition	3.55

Table 2.4 Chemical Analysis of Lime

Oxide	Percentage of Content
Cao	<90
SiO_2	< 15
MgO	< 20

A. Characterization of Sludge

The tannery sludge was characterized for various physical and chemical and heavy metals. The properties of CETP sludge me shown in Figure 1**.** In the physical & chemical characteristics of raw tannery sludge the chloride value is maximum and the hexavalent chromium as minimum.

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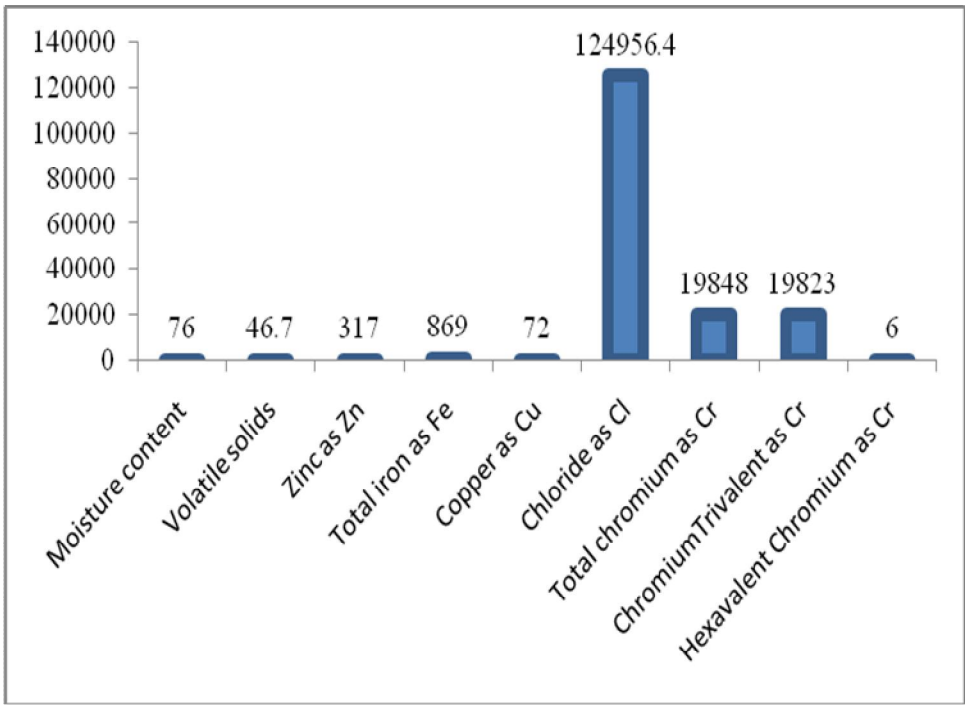

Figure 1 - Physical and chemical characteristics of Raw tannery sludge

III.METHODS & EMPLOYED

A. Mix Preparation

The CETP sludge sample is mixed with lime in the order of 10%. 20%, 30%, 40%, and 50%. Then the characteristic of each mix has analyzed. The result is given in Figures. By adding 10 % of lime the chloride is in high and volatiles solids and copper as in minimum.

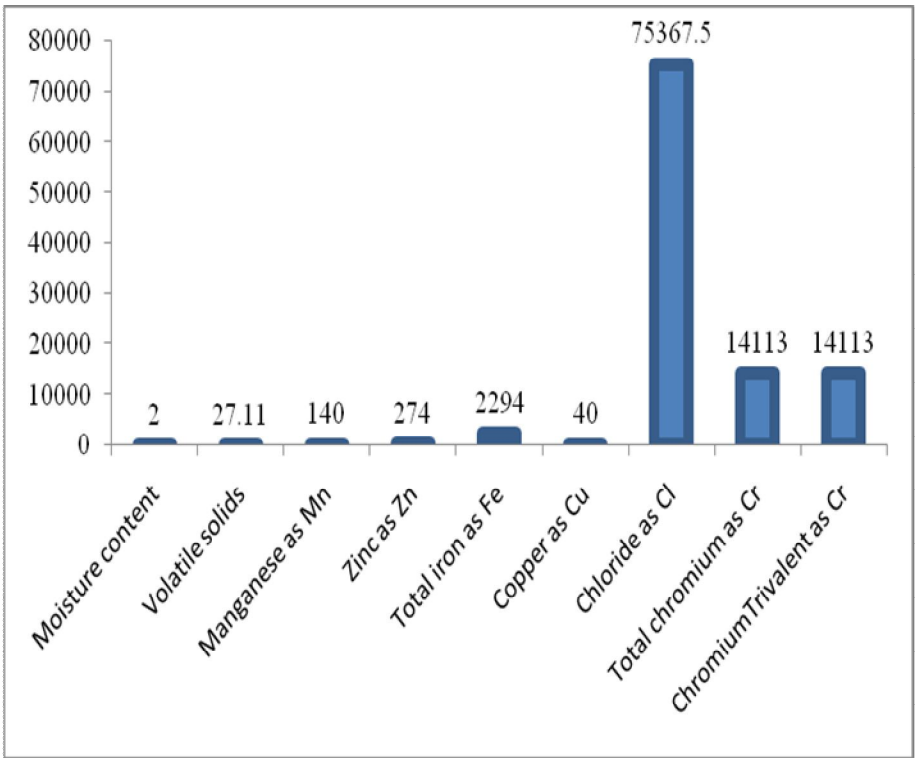

Figure 2 – Physical and chemical characteristics of raw tannery sludge + 10 % lime

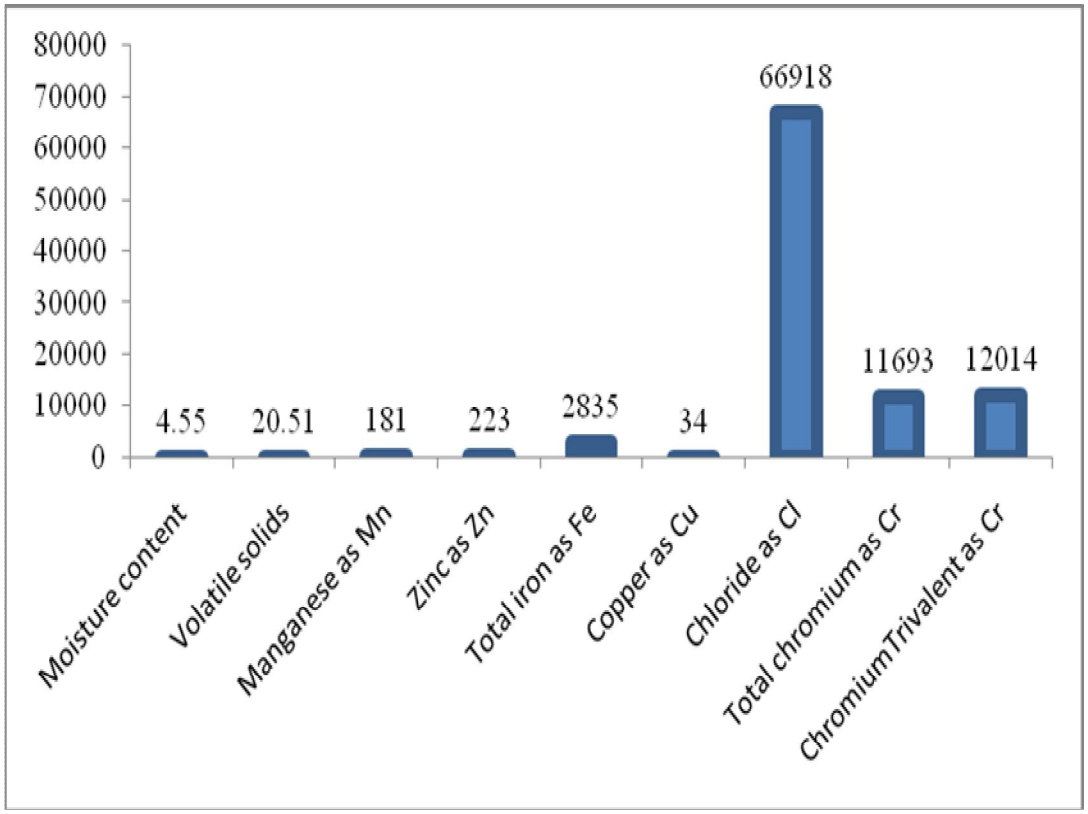

Figure 3 – Physical and chemical characteristics of raw tannery sludge + 20 % lime

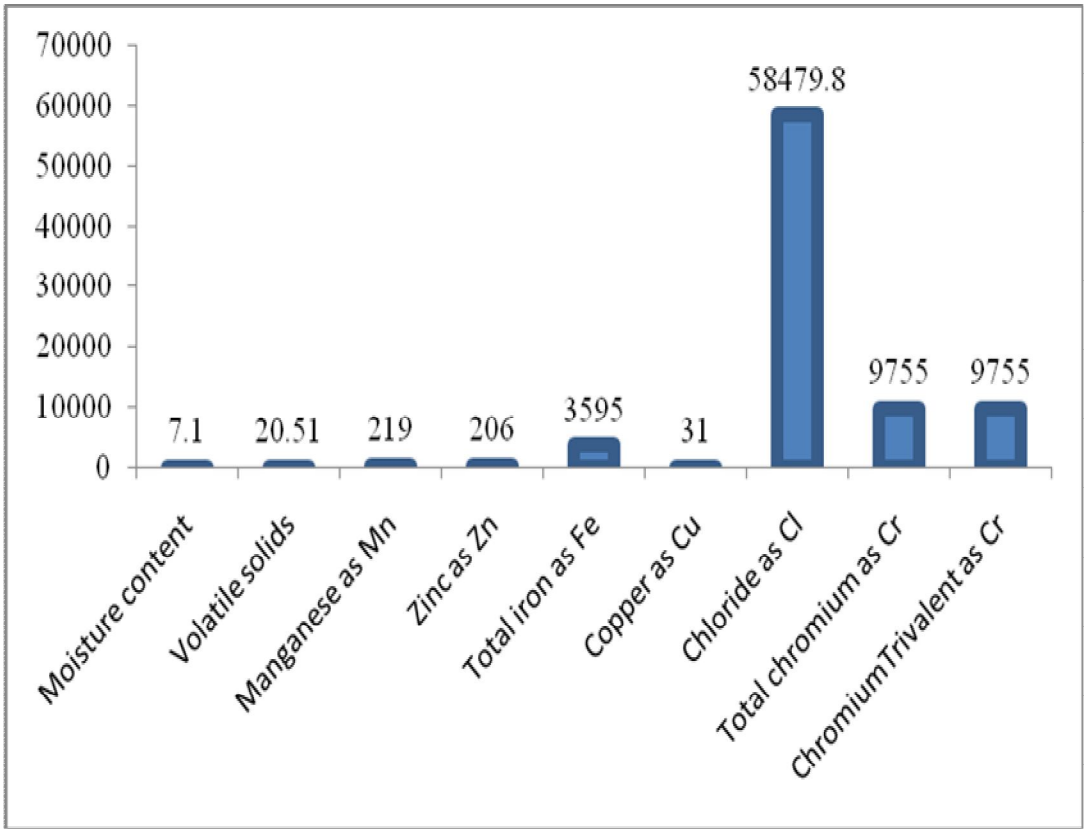

Figure 4 – Physical and chemical characteristics of raw tannery sludge + 30 % lime

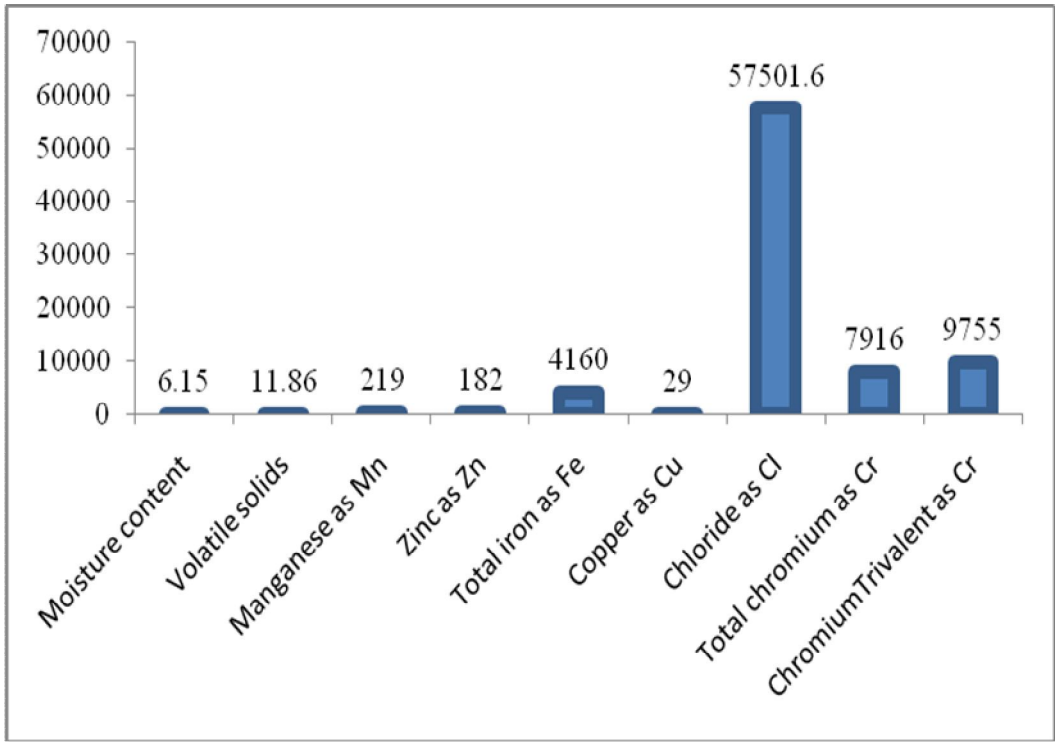

Figure 5 – Physical and chemical characteristics of raw tannery sludge + 40 % lime

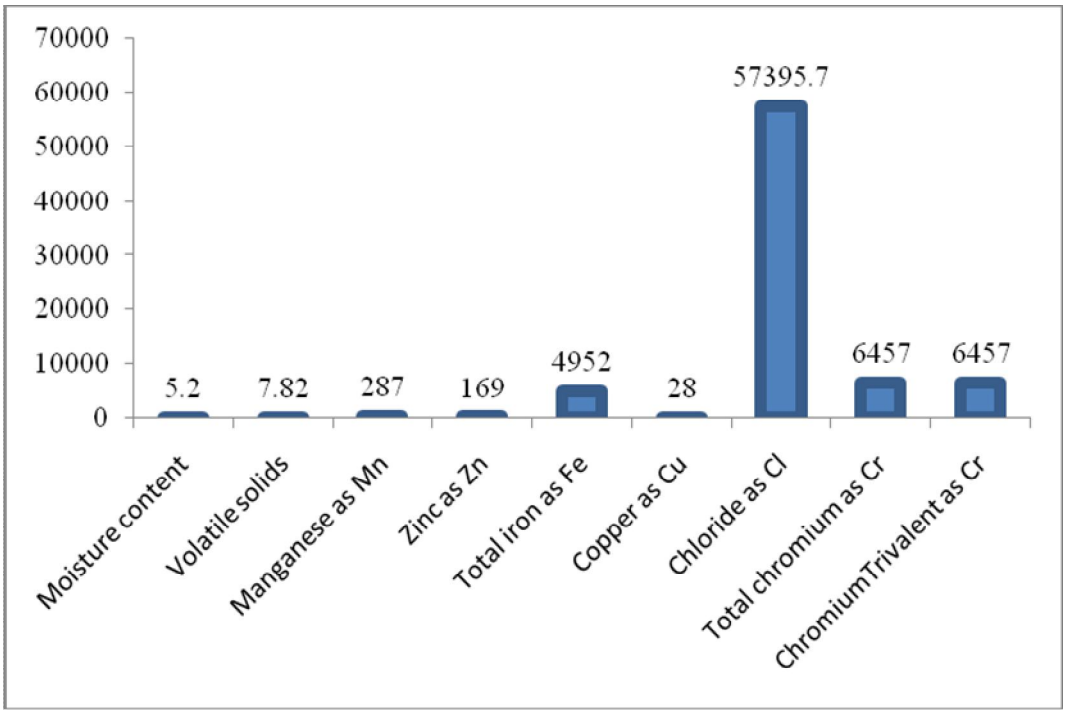

Figure 6 – Physical and chemical characteristics of raw tannery sludge + 50 % lime

As well as 20 %, 30%, 40 %, 50 % of lime the chloride are maximum. Refer Figures 3,4,5 and 6 respectively. The test results show the increasing lime quantity in sludge will decrease the toxicity level in the sludge. In our research we take 30 % lime for our further investigation and 30 % of lime added to the sludge. During the course of this experiment, efforts were taken to assure the

homogeneity of fly ash and sludge. The sludge was first dried in an over at 103° C and ground for monitoring uniformity size, Its sieved by 9.5 mm size sieved. It helps to aid workability of sludge fly ash – cement mixture. The composition of different mixes for each sludge type is given in

Table 3.1.5

Mix	Sludge + Lime (%)	OPC (%)	Fly ash
A1	95	5	0
A2	90	5	5
A3	85	5	10
A4	80	10	10
A5	75	10	15
A6	70	15	15

The sludge – cement – fly ash mixture was cast in 70.6 (50 cm^2) cubes and left to air – curing. Wet curing was initially done but samples with high proportion of fly ash, lime disintegrated in the curing water. The lime reacts with water. The heat liberated results the thermal cracking in the cases and weakened the sludge mix. Air curing was adopted for all the samples. Without OPC the cubes too weak for compressive strength test. The gradual increase of cement quantity is shows the increase in compressive strength.

B. Compressibility Test

Compression strength of the test specimen was tested in compression testing machine FIE Compression testing machine (CTM) – 100 tones Capacity with a maximum load of 5 kN. The cubes were tested for their 3 days, 7 days, 14 days and 28 days compressive strength at a loading rate of 200 kgf/ min. the tests were carried out on all combinations of fly ash – tannery sludge and cement.

IV. RESULTS & DISCUSSION

A. Compressive strength of tannery sludge – fly ash – cement mixtures

There is lots of recommended minimum compressive strength required for solid waste disposal at landfill. The recommendation from resource conversations & recovery aetls (RCRA) the minimum compressive strength of sample is 0.3MPa. The compressive strength of the disposal waste is need compaction at the land fill site. In our research the RCRAS recommended value of 0.3 Mpa was fixed as target strength of the samples. The compressive strength of sludge – fly ash - cements matrices for 70 mm x 70 mm size.

Table 4.1.6

Sl. No	Sludge (%)	Identification mark	No. of Days	Size of specimen (mm)	Load in (N)	Compressive Strength (N/mm^2)
1	95	A1	3	70 x 70	5886	1.21
2			7	70 x 70	7848	1.61
3			14	70 x 70	8829	1.8
4			28	70 x 70	17658	3.2
5	90	A2	3	70 x 70	6867	1.4
6			7	70 x 70	10791	2.2
7			14	70 x 70	14224.	2.9

8			28	70 x 70	28449	5
9	85	A3	3	70 x 70	9810	2
10			7	70 x 70	11772	2.4
11			14	70 x 70	13734	2.8
12			28	70 x 70	27468	4.9
13	80	A4	3	70 x 70	10791	2.2
14			7	70 x 70	74224	2.9
15			14	70 x 70	15696	3.2
16			28	70 x 70	31392	5.9
17	75	A5	3	70 x 70	11772	2.4
18			7	70 x 70	15696	3.2
19			14	70 x 70	16677	3.4
20			28	70 x 70	33354	6
21	70	A6	3	70 x 70	13243	2.7
22			7	70 x 70	15696	3.2
23			14	70 x 70	18639	3.8
24			28	70 x 70	37278	7

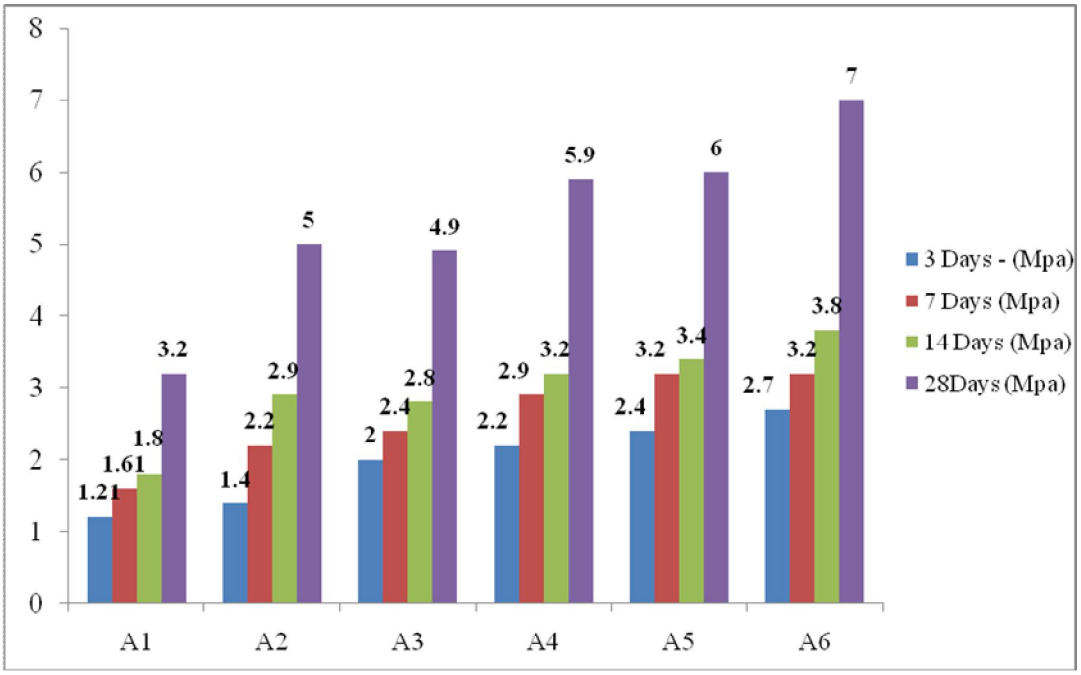

Figure 7 – Compression test comparison

Figure 7 shows a general increased in strength with increase in cement in the matrix. As the comparison of 3 days compressive strength the maximum compressive strength attain by A6 (Refer table 4.1.6). The minimum compressive strength given by all specimens to a value of 1.2 Mpa. The strength comparison of 7 days, 14 days and 28 days the maximum compressive strength taken by A6 specimen and minimum compressive strength attain by A1 specimen value of 7 Mpa and 3.2 Mpa.

B. Heavy metals leachabilty

Table shows the TCLP for the 18 specimen from the six ratios. The concentration of selected heavy metals allowed to be leached out from land fill materials is also given. To analyze all the mix proportions TCLP results the heavy metals like, total chromium (Cr), Nickel (Ni), Hexavelant, Chromium are below detective level that is 0.1 mg/lit. the trivalent chromium is also below detective level that is 0.01 mg/lit. This is lower leaching value, due to the lower concentration of solids added. General sludge has 95 % of water and 0.1 % of solid. In this research prove that fly ash and cement are very effective for lowing the toxic metals. Fly ash inherently contains lime it is strong alkali. Both OPC and fly ash maintain the sludge at high pH range 9 – 11. Immobilizing the heavy metal substances as insoluble hydrates. The OPC added to the sludge is binding the metal iron presence in the sludge. Generally the 6 mix ratios with fly ash and cement have significantly lower the leaching properly.

Table 4.2.7

Elements	Standard	TCLP Concentration of mix samples mg / lit					
		A1	A2	A3	A4	A5	A6
Total Chromium (Cr)	5	BDL0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1
Zink (Zn)	100	BDL0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1
Nickel (Ni)	5	BDL 0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1	BDL0.1
Iron (Fe)	100	820	795	740	705	650	635
Chloride (Cl)	-	242.9	241.8	239.8	236.2	234.7	232.3
Hexavelent chromium as Cr	-	BDL0.02	BDL0.02	BDL0.02	BDL0.02	BDL0.02	BDL0.02
Trivalent Chromium as Cr	-	BDL0.01	BDL0.01	BDL0.01	BDL0.01	BDL0.01	BDL0.01

V. CONCLUSIONS

The results of the study confirmed that the tannery sludge coupled with fly ash and cement could be used to solidify and stabilize heavy metal sludge. The result also shows that the fly ash can play a very important role in the stabilization and solidification process. The study show that an optimum mix compressing 70 % of sludge + lime, 15 % of fly ash and 15 % of OPC could provided the required solidification and stabilization. The matrix show necessary compressive strength for land fill damping after 28 days is 7 Mpa. When the cement content is 15 % the matrix shows the compressive strength of 3.2 Mpa having 5 % of OPC and 95 % of Lime + Sludge whichever is suited for land filling.

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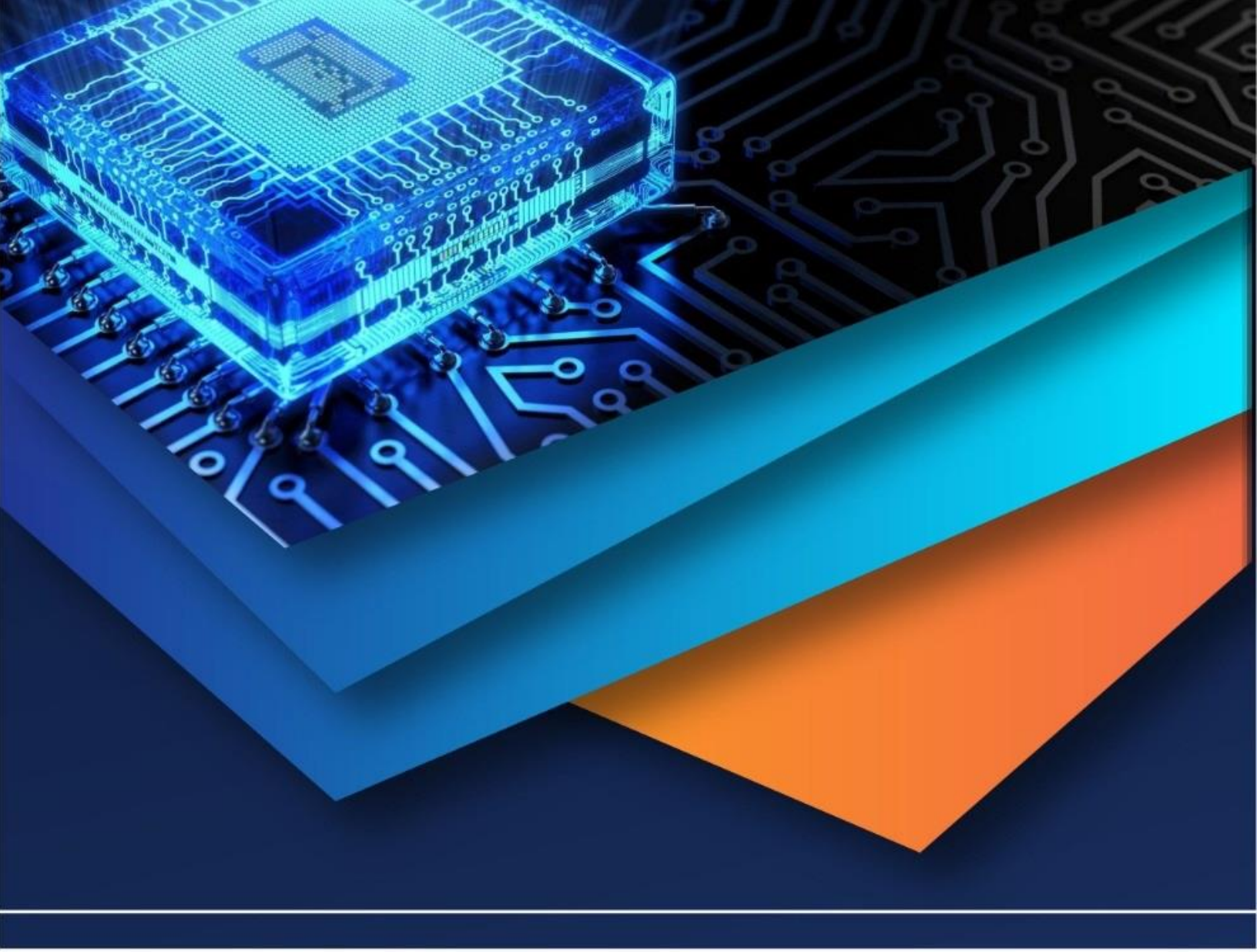

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