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A Study on the Prominent Role of pH in Altering the Engineering Behaviour of The Cement and Fly Ash Stabilized Red Mud

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ABSTRACT: Red Mud is a waste product produced from the Aluminium plants during the refining process of Red Bauxite. This can also be called as Bayer's Process residue. It consists of major silt particles and some considerable amount of fine sand. It is red in colour because of the presence of Iron Oxide in major quantity. The red mud for the current research was collected from the NALCO (National Aluminium Company) which is located at Daman Jodi in the state of Orissa. The material collected from Red Mud ponds in a wet state after that the substance was air dried at the laboratory. In order to know the reasons for variation in the Engineering properties of this material with respect to the addition of admixtures like cement and fly ash in a chemical aspect the pH tests have been carried out on all stabilized and original red mud mixes. The detailed experimental investigation ventilated the response of red mud to chemical reactions that were occurred in the samples during curing and soaking.
Key Words: Red Mud, pH, Cement, Fly Ash, admixture, EDS (Energy Dispersive Spectroscopy)

1. INTRODUCTION

Red mud is a major industrial waste generated during the production of alumina from bauxite via the Bayer process. For every tonne of aluminium produced, approximately 2.5 tonnes of red mud is generated, leading to serious challenges related to disposal and storage. Red mud is typically reddish-brown in colour, alkaline in nature, and mud-like in appearance. It is rich in iron oxides and contains significant amounts of gibbsite and goethite minerals. The disposal of red mud has emerged as a critical environmental challenge for the aluminium industry worldwide. One of the primary concerns is its highly alkaline nature, which can adversely affect soil quality and aquatic ecosystems. The seepage of alkaline leachates from red mud disposal sites into groundwater poses a serious risk to underground water resources. Red mud is generally disposed of in a wet state and stored in large open areas known as red mud ponds, which often occupy several hectares of land. Long-term storage of red mud poses severe environmental concerns, including soil degradation, air pollution, and groundwater contamination, particularly during the monsoon season. Owing to its highly caustic nature, red mud also presents potential health hazards to living organisms. Furthermore, the requirement of vast land areas for its disposal aggravates the issue of land scarcity. In addition, the safe storage of red mud remains a persistent issue due to its fine particle size, long-term instability, and potential for dam failure. When dried, red mud deposits may generate alkaline airborne dust, leading to air pollution and associated human health hazards. The disposal of red mud also requires vast areas of land, contributing to land degradation and increasing pressure on already scarce land resources. To mitigate these environmental and land-use challenges, effective utilization of red mud in value-added applications is essential. In recent decades, researchers and engineers have explored the feasibility of using red mud in various fields, particularly in civil engineering applications such as brick manufacturing, cement and concrete production, soil stabilization and road construction.

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Globally, red mud is produced in large quantities, particularly in countries such as Australia, Jamaica, Guinea, and China, with an estimated annual generation exceeding 170 million tonnes. In India, major aluminium-producing units such as Hindustan Aluminium Company (HINDALCO) at Renukoot (Uttar Pradesh), National Aluminium Company (NALCO) at Damanjodi (Odisha), Madras Aluminium Company (MALCO) at Chennai (Tamil Nadu), and Bharat Aluminium Company (BALCO) contribute significantly to red mud generation. It is estimated that nearly 9-10 million tonnes of red mud are produced annually in India and western countries combined, making its disposal a critical environmental issue.

Several studies have investigated the geotechnical and engineering properties of red mud. Li (1998) reported that red mud is highly alkaline, with a pH ranging from 11 to 13. Vogt (1974) observed a high friction angle between 38° and 42°. Somogyi and Gray (1977), and later Newson (2002), reported a compression index (Cc) in the range of 0.27–0.39, coefficient of permeability between 2×10^{-7} and 20×10^{-7} cm/s, and coefficient of consolidation (Cv) ranging from 3×10^{-3} to 50×10^{-3} cm^2/s. Subrat K. Rout (2013) classified red mud as ML soil with a specific gravity of 3.34.

Several researchers have explored its application in construction materials. Yang (1996) investigated the use of red mud and fly ash in lightweight brick production and mine backfilling using red mud–fly ash–lime grout. Qi (2005) examined its application in highway construction. Jitsangiam and Nikraz (2013) studied red mud stabilized with fly ash and lime as a base course material and identified an optimum mix of 75% red mud, 25% fly ash, and 5% lime, achieving unconfined compressive strength (UCS) values between 0.6 and 1 MPa. Kahagia (2014) successfully constructed pilot roads using 97% red mud and 3% fly ash, which exhibited excellent performance without rutting or surface deformation. Lima et al. (2015) utilized red mud in combination with crusher dust as filler material. Despite extensive research, large-scale utilization of red mud remains limited, and further systematic studies are required to assess its performance as a geotechnical construction material. The present study aims to evaluate the feasibility of red mud stabilized with cement and fly ash for civil engineering applications.

Prior Research Investigations:

Extensive research has been carried out to characterize the physical, chemical, mineralogical, and geotechnical properties of red mud to assess its potential for engineering applications.

Miners (1973) reported that red mud primarily consists of sand- and silt-sized particles, with clay-sized fractions accounting for approximately 20–30%. The study noted the absence of quartz minerals and classified the coarse fraction as red sand and the finer fraction as red mud.

Parekh and Goldberger (1976) identified red mud as a highly alkaline material containing 20–30% clay-sized particles, with the majority of particles in the silt size range. Their one-dimensional consolidation tests yielded compression index (Cc) values between 0.27 and 0.39, permeability values ranging from 2 to 20×10^{-7} cm s^{-1}, and coefficients of consolidation (Cv) on the order of 3–50 $\times 10^{3}$ cm^{2} s^{-1}.

Vick (1981) reported that red mud exhibits low plasticity, with a liquid limit of approximately 45% and a plasticity index of about 10%, along with relatively high specific gravity values in the range of 2.8–3.3. Owing to the limited presence of clay minerals, red mud was found to exhibit geotechnical behavior similar to that of clayey tailings.

Li (1998) characterized red mud as a highly alkaline waste material with pH values between 11 and 13. The mineralogical composition was reported to include hematite, goethite, gibbsite, calcite, sodalite, and complex silicates. In several cases, more than 50% of the particles were finer than 2 µm, and the cation exchange capacity of red mud was found to be comparable to that of kaolinite or illite.

Sundaram and Gupta (2010) conducted in-situ investigations to evaluate the feasibility of using red mud as a foundation material. Their findings indicated alkaline pH values ranging from 9.3 to 10.2, liquid limits between 39 and 45%, plastic limits of 27–29%, and shrinkage limits of 19–22%. The undrained shear strength varied from 0.4 to 1.4 kg cm^{-2}, with specific gravity values of 2.85–2.97, cohesion ranging from 0.1 to 0.2 kg cm^{-2}, and internal friction angles between 26° and 28°.

A critical review of the existing literature reveals that although the physical, chemical, and geotechnical characteristics of red mud have been extensively investigated, limited attention has been paid to the durability performance of red mud-based materials.

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Durability is a key parameter governing the long-term stability and service life of civil engineering structures, particularly under varying environmental exposure conditions. Despite the wide coverage of red mud research across various domains of civil engineering, further studies are essential to meet the demands of rapid infrastructure development while ensuring environmental protection.

The sustainable utilization of red mud not only addresses the challenges associated with industrial waste disposal but also contributes to the conservation of natural soil resources and the mitigation of land scarcity issues. Therefore, the present study aims to bridge the identified research gaps by systematically investigating the durability and performance of stabilized red mud composites for environmentally sustainable construction applications.

2. MATERIALS AND METHODS

Red Mud

Red mud used in the present study was collected from an aluminium manufacturing plant named NALCO, (National Aluminium Company) which is located at Damanjodi in Orissa state. The material was air-dried, pulverized, and sieved prior to laboratory testing.

Disposal of Red Mud into ponds at NALCO, Damanjodi, Orissa

(a) Slurry type of red mud

(b) Dried red mud

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Collection of Red Mud from NALCO Damanjodi, Odisha

Physical Properties of Red Mud:

The Physical appearance and nature of the Red Mud has been identified and manifested in the tabular form below.

Table 1. Physical characteristics of red mud

Sr. No.	Property	Value
1	Appearance	Mud
2	Colour	Dark Red
3	Odour	Pungent
4	Texture	Fine
5	Specific Gravity	3.05
6	Specific Surface (m2/gm)	18
7.	pH	10.3

Chemical composition of Red Mud:

The Red Mud after the disposal from the Aluminium factory into the Red Mud pond has been collected and air dried at the laboratory. Chemical compounds that are present in the Red Mud have been investigated using Energy Dispersive Spectroscopy (EDS) test. The test findings are presented in the following table.

Table 2. Chemical composition of red mud

Compound formula	Percentage
Na_2O	7.750
Al_2O_3	22.840
SiO_2	19.840
CaO	1.240
TiO_2	7.870
V_2O5	0.680
FeO	39.320
ZnO	0.450

From the test results of EDS (Energy Dispersive Spectroscopy) it is observed that red mud is dominated by oxides of iron followed by silica and alumina. It has very low amount of CaO (1.24%) hence it is not self-Puzzolanic. It also consists of 43 % of alumina and silica and 82 % together with oxides of iron. Addition of admixtures such as Cement, Fly Ash, GGBFS and Lime etc, can make the red mud cementitious and Puzzolanic with time.

Cement

Ordinary Portland Cement (OPC) of 43grade was used as a stabilizing agent. Cement was added in varying percentages to evaluate its effect on the strength and durability characteristics of red mud.

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Fly Ash

Class F fly ash collected from NTPC (National Thermal Power Corporation, Visakhapatnam) was used as a supplementary material due to its Puzzolanic properties and availability.

Physical Properties of Fly Ash:

It is an unused product disposed from Thermal power plants. It is obtained during the process of burning of Coal from Thermal power plants. In the present study fly ash was collected from the NTPC (National Thermal Power Corporation) which is located at Parawada in Visakhapatnam, Andhra Pradesh and the collected Fly ash was dried and tested for required physical and geotechnical parameters as per IS 2720.

Table 3. Physical Properties of fly ash

Sr. No.	**Property**	**Value**
1	Colour	Grey
2	Texture	Fine
3	Specific Gravity	2.2

Chemical Composition of Fly Ash:

The collected Fly Ash has been subjected to EDS test to identify the chemical substances existing in that matter. The proportionate share of the chemical compounds is as follows.

Table 4. Chemical composition of fly ash.

Compound	**Formula**	**Percentage (%)**
Silica dioxide	SiO_2	59.83
Aluminium trioxide	Al_2O_3	30.48
Calcium oxide	CaO	1.74
Magnesium oxide	MgO	0.86
Titanium oxide	TiO_2	6.91
Zinc oxide	ZnO	0.09

Mix Proportions

The following combinations were prepared and tested:

- Red mud with different percentages of cement
- Red mud with varying proportions of fly ash
- Fly ash with diverse amounts of cement
- Red mud blended with 40% fly ash and different dosages of cement

Curing

Prepared specimens were cured for predetermined periods under controlled laboratory conditions to study the variation in strength development..

Soaking after Curing

After completion of the curing period, specimens were soaked in water to assess the durability and strength retention under saturated conditions.

3. Experimental Program:

The pH was also determined for all proportions of mixes to know about the chemical nature interaction between red mud and cement particles. Change of elements played a vital role in inducing the strengths of the mixes.

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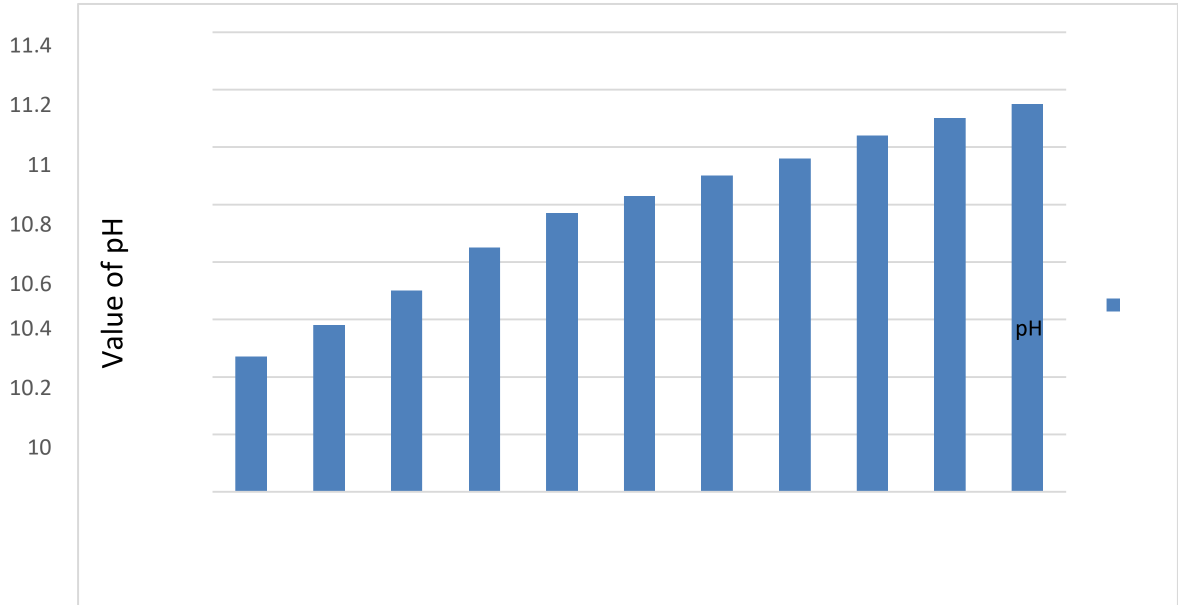
Table 5. Variation of pH for red mud with cement mixes

Percentage of Cement	Value of pH
0	10.270
2	10.380
4	10.500
6	10.650
8	10.770
10	10.830
12	10.900
14	10.960
16	11.040
18	11.100
20	11.150

Figure 1. Variation of P^H values of red mud with cement content.



Based on the test results, it is observed that an increase in cement content leads to a corresponding increase in the pH of the red mud–cement matrix. This behavior is attributed to the higher concentration of free lime released into the pore solution due to cement hydration. The elevated pH creates a highly alkaline environment, which promotes and accelerates the formation of cementitious and Puzzolanic reaction products. Consequently, this enhanced alkalinity contributes to improved strength characteristics of the stabilized matrix, as reflected by increased Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) values.

Energy Dispersive Spectroscopy:

To identify the chemical composition of the cement stabilized red mud samples EDS is performed. The results are as follows

Table 6. Chemical composition of red mud with 8%cement mix.

Compound	Quantity (%)
Na_2O	29.370
SiO_2	24.770
CaO	16.520
FeO	29.340

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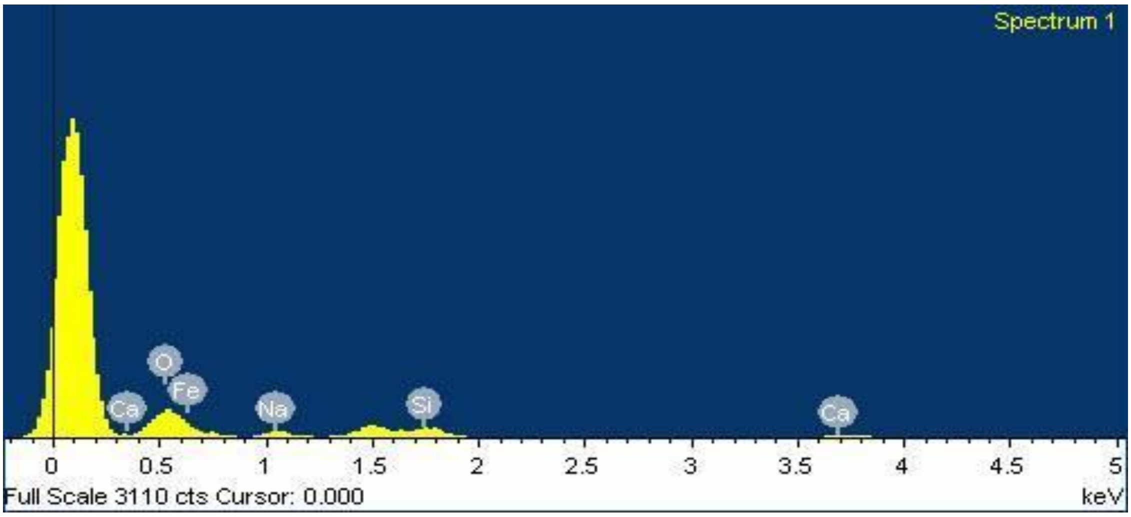
Figure 2. Chemical Composition of Red Mud with 8% Cement.

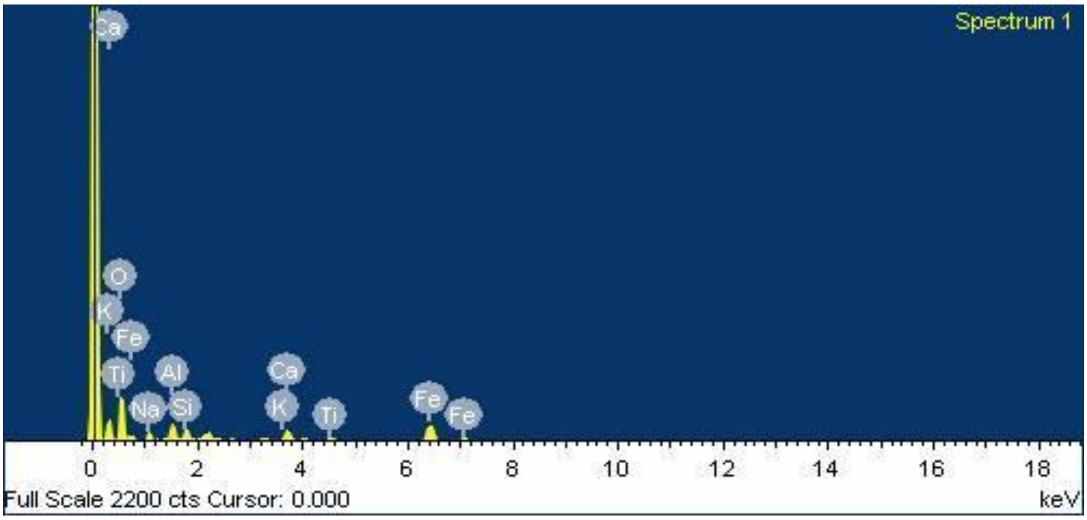


Based on the test results, it is observed that an increase in cement content leads to a corresponding rise in CaO concentration in red mud–cement blends. A simultaneous increase in the proportion of reactive silica is also noted. The availability of free lime (CaO) facilitates Puzzolanic reactions with silica, alumina, and iron-bearing compounds present in red mud, resulting in the formation of calcium silicate hydrate (C–S–H), calcium aluminate hydrate (C–A–H), and calcium ferrite hydrate (C–Fe–H) gels. The development of these hydration products significantly contributes to the densification of the matrix and consequent enhancement of the mechanical strength of the red mud composites.

Table 7. Chemical composition of red mud with 10% cement

Compound	Quantity (%)
Na_2O	06.680
SiO_2	13.080
CaO	24.150
FeO	20.920
Al_2O_3	17.370
TiO_2	17.020
K_2O	0.780

Figure 3. Chemical Composition of Red Mud with 10% Cement



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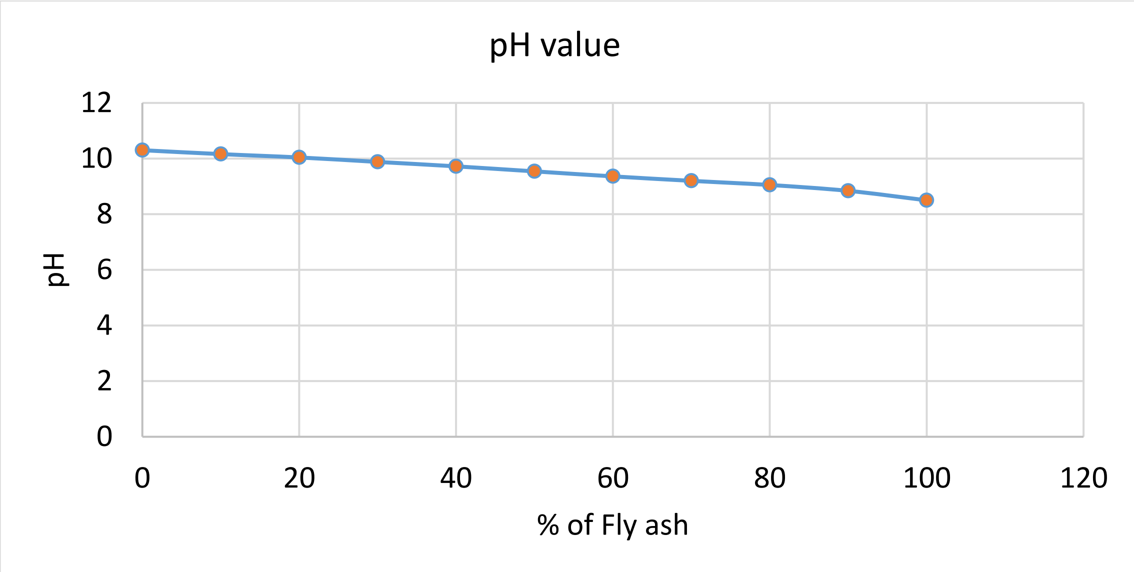
Red Mud + Fly Ash: Red mud-fly ash mixes were tested for pH values to study the chemical behaviour. The variation in the values are as shown below.

Table 8. Variation of pH values for red mud with fly ash mixes

Red mud-Fly ash mixes	Value of P^H
100-0	10.300
90-10	10.160
80-20	10.040
70-30	9.880
60-40	9.720
50-50	9.540
40-60	9.360
30-70	9.200
20-80	9.050
10-90	8.840
0-100	8.500

Figure 4. Variation of pH values for red mud with fly ash samples



The experimental results indicate a systematic reduction in pH with increasing fly ash content in red mud–fly ash blends. This behavior is primarily governed by the inherent alkalinity of the constituent materials, as red mud exhibits a higher pH (~10.3) than fly ash (~8.5). Partial replacement of red mud by fly ash results in a dilution of alkaline components, particularly free lime and alkali metal oxides, leading to a progressive decrease in the pH of the pore solution. From a chemical perspective, the reduced availability of CaO limits the formation of hydroxyl ions (OH^-), thereby lowering the alkalinity of the system. Consequently, the pore fluid does not attain the highly alkaline conditions required to effectively dissolve amorphous silica and alumina phases present in fly ash, which are essential precursors for sustained Puzzolanic activity. As a result, the formation of cementitious reaction products such as calcium silicate hydrate (C–S–H) and calcium aluminate hydrate (C–A–H) is restrained with time, potentially influencing the long-term strength development and durability of the stabilized matrix.

Energy Dispersive Spectroscopy

To understand the experimental findings the fly ash stabilized red mud samples for chemical composition listed below.

The results are as follows.

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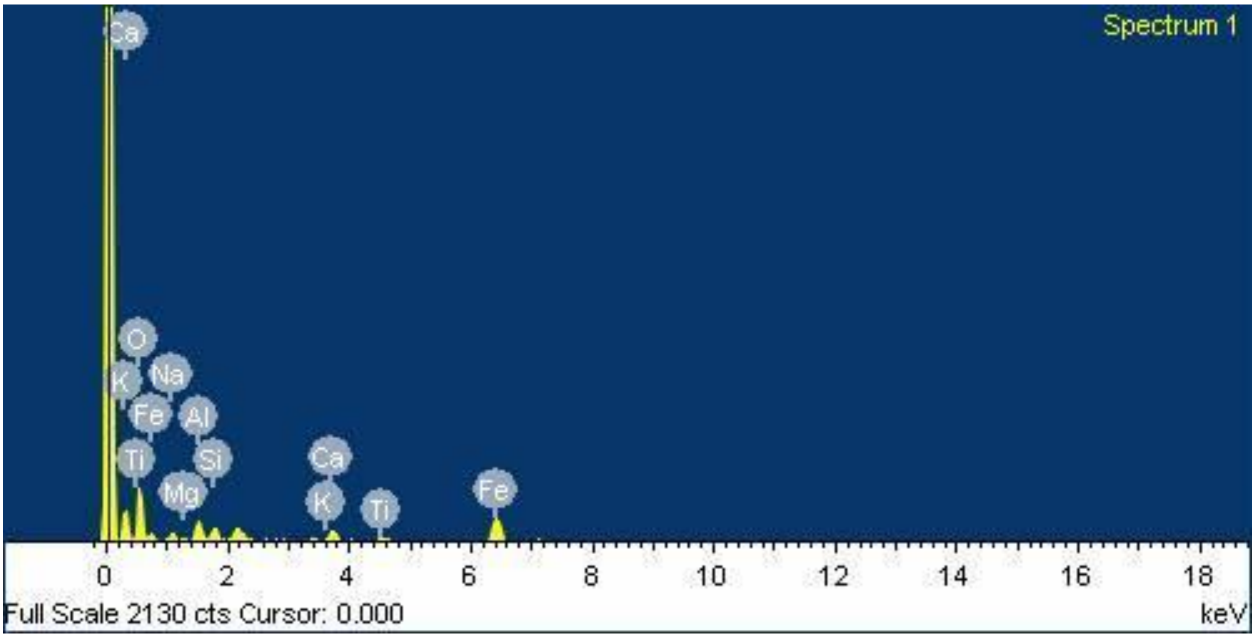
Table 9. Chemical composition of RM + 40%Fly Ash mix.

Compound	**Quantity (%)**
Na_2O	4.730
SiO_2	22.110
CaO	2.170
FeO	30.510
Al_2O_3	25.040
TiO_2	14.180
K_2O	0.600
MgO	0.650

Figure 5. chemical composition of RM+40%Fly Ash mix



Fly Ash + Cement: The P^H was tested for Cement Stabilized Fly ash mixes to study the Chemical Behaviour. The variation in the values are as shown below

Table 10. variation of P^H values for fly ash with cement mixes

Cement (%)	**Value of P^H**
0	8.520
2	8.700
4	8.940
6	9.060
8	9.270
10	9.500

From the above table and figure it is observed that rise in the pH values occur due to increase in dosage of cement to fly ash. The presence of calcium oxide, silica and alumina in cement results in higher values of pH.

Energy Dispersive Spectroscopy

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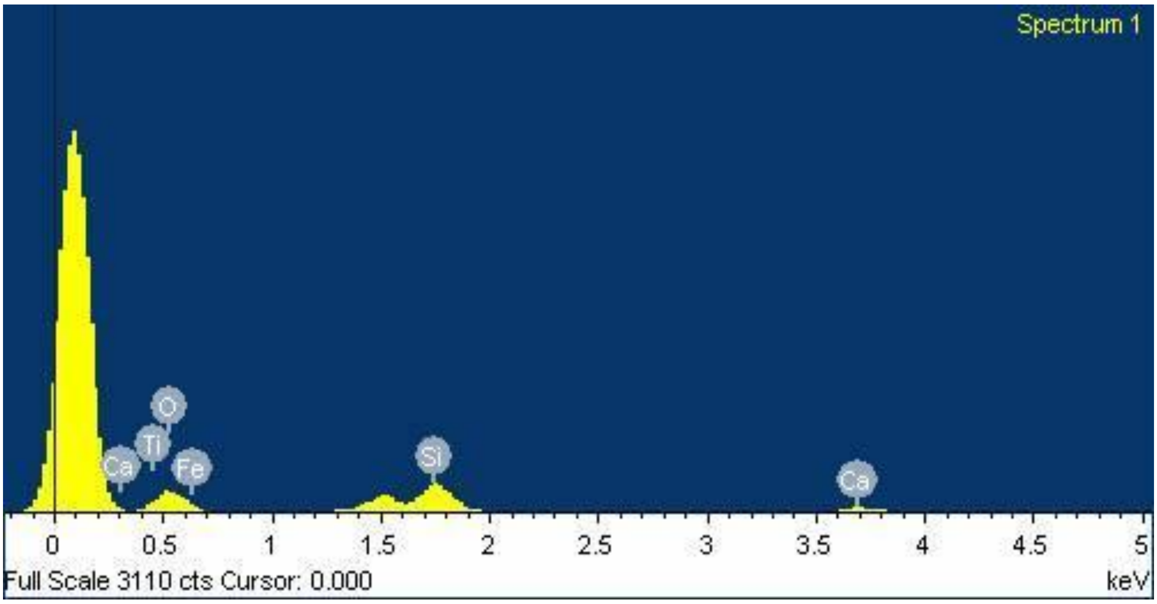
Table 11. Chemical composition of fly ash + 10% cement.

Compound	Quantity (%)
SiO_2	69.200
CaO	16.150
FeO	8.570
TiO2	6.080

Figure 6: Variation of Chemical Composition for Fly Ash + 10% Cement



Red Mud + Fly Ash + Cement: The P^H was tested for Cement and Fly ash Stabilized Red mud mixes to study the Chemical Behaviour. The variation in the values are as shown below.

Table 12. variation in P^H values for RM+ FA+ Cement mixes

Percentage of Cement / Percentage of Fly Ash	0	2	4	6	8	10
0	10.270	10.380	10.500	10.650	10.770	10.830
10	10.160	10.300	10.400	10.520	10.630	10.750
20	10.040	10.200	10.260	10.400	10.520	10.690
30	9.880	10.050	10.180	10.300	10.430	10.620
40	9.720	9.880	10.010	10.180	10.340	10.490
50	9.540	9.680	9.800	9.980	10.160	10.260
60	9.360	9.450	9.620	9.800	9.920	10.150
70	9.201	9.320	9.480	9.650	9.840	10.020
80	9.050	9.170	9.250	9.420	9.630	9.870
90	8.820	8.960	9.100	9.280	9.450	9.720
100	8.520	8.700	8.940	9.060	9.270	9.500

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The pH trends shown in the Figure and Table reveal a systematic decrease in alkalinity with increasing fly ash content. This reduction is primarily attributed to the lower concentration of free alkaline oxides and the presence of unburnt carbon and organic residues in fly ash, which dilute the alkaline environment of the system. Conversely, for a given mix composition, increasing cement dosage leads to a progressive rise in pH due to the enhanced availability of calcium oxide. Upon hydration, CaO forms calcium hydroxide, thereby increasing pore solution alkalinity.

At lower fly ash contents, the chemical composition of the mixes is dominated by iron oxide, silica, alumina, and calcium oxide derived from red mud and cement, resulting in a highly alkaline matrix that favours hydration and Puzzolanic reactions. As the proportion of fly ash increases, the relative dominance of less reactive carbonaceous phases and reduced free lime availability suppresses alkalinity, leading to the observed decline in pH. These results highlight the critical role of oxide chemistry and phase composition in governing the pH evolution of red mud–fly ash–cement composites.

The above Figure and Table represents that pH values dropped gradually with increase in percentage of fly ash this is due to presence of organic content and carbon in fly ash. For individual combinations with increase in cement dosage rise in pH values was observed because more addition of cement results in increasing calcium oxide, silica and alumina. Initially the mixes dominated by iron oxide, silica, calcium oxide and alumina due to more amount of red mud and cement, later on when fly ash content increases the mixes dominated by more carbon content which leads to the fall in pH values.

Interpretation of Results:

The experimental results provide significant insights into the chemical and mechanical behaviour of red mud stabilized with cement and fly ash. The pH measurements indicate that increasing cement content in red mud–cement mixtures leads to a progressive rise in alkalinity, attributed to the higher concentration of free lime (CaO) released during cement hydration. This elevated pH environment promotes the formation of cementitious and Puzzolanic reaction products, such as calcium silicate hydrate (C–S–H), calcium aluminate hydrate (C–A–H), and calcium ferrite hydrate (C–Fe–H) gels, which contribute to matrix densification and enhanced mechanical strength. Energy Dispersive Spectroscopy (EDS) confirms that the increased CaO and reactive silica concentrations facilitate these hydration and Puzzolanic reactions, directly correlating with improved Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) values.

Conversely, incorporation of fly ash into red mud results in a systematic decrease in pH, reflecting the dilution of alkaline components due to the lower inherent alkalinity of fly ash (~8.5) compared to red mud (~10.3). The reduced availability of free lime in high fly ash blends limits the formation of hydroxyl ions and consequently constrains the dissolution of amorphous silica and alumina, which are crucial for sustained Puzzolanic activity. This behavior explains the comparatively slower or restrained development of cementitious products in red mud–fly ash–cement composites at higher fly ash contents. The chemical composition data further indicate that lower fly ash proportions maintain a highly alkaline environment dominated by reactive oxides from red mud and cement, whereas higher fly ash content introduces carbonaceous and less reactive phases, suppressing alkalinity and potentially affecting long-term durability.

Overall, the results highlight the critical influence of cement and fly ash proportions on both the chemical and mechanical properties of red mud-based composites, underscoring the role of pH and oxide chemistry in governing strength development and durability.

CONCLUSION:

The present study demonstrates that red mud is an industrial waste generated in large quantities from alumina production, can be effectively stabilized using cement and fly ash to produce mechanically robust composites suitable for civil engineering applications. Cement addition significantly enhances the alkalinity of red mud, promoting Puzzolanic and hydration reactions that lead to the formation of C–S–H, C–A–H, and C–Fe–H gels, resulting in improved Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) values. Incorporation of fly ash influences the chemical environment by reducing alkalinity, which can moderate long-term Puzzolanic activity; however, optimal proportions of red mud, cement and fly ash yield a balanced matrix with desirable strength and durability characteristics.

It is prominent that the utilization of red mud in such stabilized composites provides an environmentally sustainable solution by converting a hazardous industrial waste into a value-added construction material. This approach not only mitigates the adverse environmental impacts associated with red mud disposal, such as soil and water contamination, but also contributes to eco-friendly and resource-efficient construction practices. Overall, red mud–cement–fly ash composites offer a promising and sustainable pathway for waste valorization, supporting both engineering performance and Clean environmental sustainability.

REFERENCES

[1] Satyanarayana, P.V.V., Hanumantha Rao, C.H., and Naidu, S. (2018). Effect of curing on strength characteristics of red mud–fly ash mixes. *SSRG International Journal of Civil Engineering*, 5(8).
[2] Hanumantha Rao, C.H. (2018). Comparison of engineering properties of red mud, an aluminium industrial waste, with natural soils. *Journal of Engineering Research and Application*, 8(1), 3–7.
[3] Hanumantha Rao, C.H., Satyanarayana, P.V., Jahara, S.K., and Prasanth, K. (2018). Relative performance of red mud over red soils as construction material. *IOSR Journal of Mechanical and Civil Engineering*, 15(5), 1–9.
[4] Satyanarayana, P.V., Hanumantha Rao, C.H., and Jahara, S.K. (2018). Engineering properties of compacted red mud. *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development*, 8(5), 1–6.
[5] Deelwal, K., Dharavath, K., and Kulshreshtha, M. (2014). Evaluation of characteristic properties of red mud for possible use as a geotechnical material in civil construction. *International Journal of Advances in Engineering and Technology*, 7(3), 1053–1059.
[6] Chen, X., Lu, A., and Qu, G. (2013). Preparation and characterization of foam ceramics from red mud and fly ash using sodium silicate as a foaming agent. *Ceramics International*, 39(2), 1923–1929. https://doi.org/10.1016/j.ceramint.2012.08.042
[7] He, H., Yue, Q., Su, Y., Gao, B., Gao, Y., Wang, J., and Yu, H. (2012). Preparation and mechanical properties of sintered bricks produced from Yellow River sediment and red mud. *Journal of Hazardous Materials*, 203–204, 53–61. https://doi.org/10.1016/j.jhazmat.2011.11.095
[8] Sundaram, A., and R. Gupta. 2010. "Constructing Foundations on Red Mud." Paper presented at the 6th International Conference on Environmental Geotechnics (ICEG), New Delhi, India.
[9] Hannachi, Y., Shapovalov, N.A., and Hannachi, A. (2010). Adsorption of nickel from aqueous solution using low-cost adsorbents. *Korean Journal of Chemical Engineering*, 27, 152–158.
[10] Huang, W., Wang, S., Zhang, Z., Li, L., Yang, X., and Victor, R. (2008). Phosphate removal from wastewater using red mud. *Journal of Hazardous Materials*, 158(1), 35–40.
[11] Cablik, V. (2007). Characterization and applications of red mud from bauxite processing. *Gospodarka Surowcami Mineralnymi (Mineral Resources Management)*, 23(4), 29–38.
[12] Chaddha, M.J., Rai, S.B., and Goyal, R.N. (2007). Characteristics of red mud of Indian alumina plants and their possible utilization. In *Proceedings of ENVICON-2007: National Seminar on Environmental Concerns and Remedies in Aluminum Industry* (pp. 41–44). NALCO, Damanjodi, India.
[13] Klakan, E. (2006). Utilisation of red mud as a stabilisation material for the preparation of clay liners. *Engineering Geology*, 87(3–4), 220–229.
[14] Udoeyo, F.F., Iron, U.H., and Odium, O.O. (2006). Strength performance of laterized concrete. *Construction and Building Materials*, 20, 1057–1062.
[15] Aydogmus, T., Alexiew, D., and Klapperich, H. (2004). Investigation of interaction behaviour of cement-stabilized cohesive soil and PVA geogrids. In *Proceedings of the Third European Geosynthetics Conference*. Munich, Germany.
[16] Bahar, R., Benazzoug, M., and Kenai, S. (2004). Performance of compacted cement-stabilized soil. *Cement and Concrete Composites*, 26, 811–820.
[17] Agarwal, A., Sahu, K.K., and Pandey, B.D. (2004). Solid waste management in non-ferrous industries in India. *Resources, Conservation and Recycling*, 42, 99–120.
[18] Akbulut, S., and Saglamer, A. (2003). Evaluation of fly ash and soil in grouting. In *Grouting and Ground Treatment* (pp. 1192–1199). ASCE. https://doi.org/10.1061/40663(2003)67
[19] Akbulut, S., and Saglamer, A. (2002). Estimating the groutability of granular soils: A new approach. *Tunnelling and Underground Space Technology*, 17(4), 371–380. https://doi.org/10.1016/S0886-7798(02)00040-8
[20] Fathey, M., Newson, T.A., and Fujiyasu, Y. (2002). Engineering with tailings. In *Proceedings of the 4th International Conference on Environmental Geotechnics* (Vol. 2, pp. 947–973). Balkema, Lisse.
[21] Annual Report, Ministry of Mines, Government of India. (1999–2000). Chapter V.
[22] Li, L. Y. 1998. "Properties of Red Mud Tailings Produced Under Varying Process Conditions." *Journal of Environmental Engineering* 124, no. 3: 254–264.
[23] Smirnov, D.I., and Molchanova, T.V. (1997). Sulphuric acid sorption recovery of scandium and uranium from red mud of alumina production. *Hydrometallurgy*, 45(3), 249–259.
[24] Greaves, H.M. (1996). An introduction to lime stabilisation. In *Proceedings of Seminar on Lime Stabilisation* (pp. 5–12). Thomas Telford, London.
[25] Houben, H., and Guillaud, H. (1994). *Earth Construction: A Comprehensive Guide*. Intermediate Technology Publications, London.
[26] Bell, F.G. (1989). Stabilisation and treatment of clay soils with lime. *Ground Engineering*, 21(1), 10–15.
[27] Amritphale, S.S., and Patel, M. (1987). Utilization of red mud and fly ash for manufacturing bricks with pyrophyllite. *Silicates Industriels*, 52(3–4), 31–35.
[28] Borden, R., and Groome, D.M. (1984). Influence of bentonite cement on the pumpability of compaction grouts. *ACI Special Publication*, 83, 115–128.
[29] Balogun, L.A., and Adepegba, D. (1982). Effect of varying sand content in laterized concrete. *International Journal of Cement Composites and Lightweight Concrete*, 4(4), 235–241.
[30] Vick, S. G. (1981). *[Title of original report on geotechnical properties of red mud]*. As cited in Bhumij, R. K. (2015). *Compaction and consolidation behaviour of untreated and treated waste of Indian red mud* (e.g., thesis, which refers to Vick 1981 observed low plasticity and high specific gravity).
[31] Parekh, D. M., & Goldberger, L. (1976). Geotechnical properties of red mud from alumina refining. *In Proceedings of the 2nd International Symposium on Use of Industrial By-Products in Construction* (pp. 201–212).
[32] Bokhari, A.H. (1976). *A study of soil–cement blocks in building construction* (M.Sc. thesis). University of Engineering and Technology, Lahore, Pakistan.
[33] Miners, K. 1973. "Alcan's Experience of the Disposal of Red Mud from the Bayer Ore Process." In *Proceedings of the 1st International Tailings Symposium*, 553–562.
[34] Breck, D.W., and Flanigen, E.M. (1968). *Molecular Sieves*. Society of Chemical Industry, London.
[35] Fitzmaurice, R. (1958). *Manual on Stabilized Soil Construction for Housing*. United Nations, New York.
[36] Neville, A.M., and Brooks, J.J. *Concrete Technology*. Longman Group, London.
[37] IS 2720 (Part 26). Determination of pH of soil. Bureau of Indian Standards, New Delhi.
[38] IRC 50 Design Considerations, *Indian Roads Congress*, New Delhi.
[39] Adsorption of phosphate from aqueous solution using activated red mud. *Technical report / unpublished data*.
[40] Red mud–based adsorption studies (phosphate removal). *Related technical documentation and reports*.
[41] Department of Research, Energy and Tourism. Australia. *Government technical reports*.
[42] Beijing Journal Research Institute. China. *Research and technical publications*.
[43] Geology Data.info. Information portal on geology with special reference to bauxite deposits in Rajasthan, India. Available at: www.geologydata.info/bauxite_deposits.htm