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Use of Red Mud as An Inferior Building Material

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ABSTRACT
Aluminum's usage as a steel and wood alternative has resulted in rapid growth for the aluminium sector. Aluminum manufacturing leaves behind red mud as a byproduct. Red mud leftovers amount to 1 to 2 tonnes of dry weight each tonne of aluminium produced. The main aim of the study is Use of Red Mud as an Inferior Building Material. A computational approach and an experimental investigation of red mud are both included in the current work. Investigation of morphology, chemical composition, and mineralogy and geotechnical properties of red mud as a subgrade material is the experimental approach. It is concluded that red mud as a subgrade building material is investigated in this research using laboratory geotechnical testing, model footing tests, and FE modelling.
Keywords: Red mud, pavement subgrade material, model footing, finite element analysis, erosion.

1. Introduction
New advancements in a country's industrial and agricultural operations are vital for increasing its economic value and satisfying its people's basic desires. Water is one of the most important resources for both industrial and agricultural growth. Massive development activities in the industrial and agricultural fields have developed and emitted various poisonous pollutants in recent years, which are the primary sources of global water pollution. The types of contaminants found in wastewater are largely determined by the raw materials utilized in industrial processes. It is common knowledge that industrial wastewaters contain a large number of organic and inorganic compounds.
Water pollution is mostly caused by organic pollutants such as dichloro-diphenyltrichloroethane, aminos, dyes, and phenolics, as well as inorganic heavy metals. Heavy metals are widely employed for a variety of procedures in a variety of sectors. These businesses are discharging effluents into the environment without first treating them properly. Toxic heavy metals' release and persistence in the natural environment are a severe concern, particularly in urban settings. Pollutants containing heavy metals can be hazardous to aquatic life and contaminate groundwater when released into the environment. Heavy metals have been removed from wastewaters using a variety of methods. Chemical precipitation, ion exchange, membrane filtration, and electrolysis are examples of these processes. These technologies, on the other hand, require a lot of money and a lot of energy.
The Bayer process is used to manufacture alumina from the mineral bauxite. Bauxite is a mineral ore that occurs naturally in mineral combinations. Aluminum oxide (Al_2O_3) is the most abundant component of bauxite, followed by iron oxide (Fe_2O_3), silicon dioxide (SiO_2), calcium oxide (CaO), magnesium oxide (MgO), potassium oxide (K_2O), and titanium dioxide (TiO_2). According to India's Ministry of Mines' annual report (2016-2017), the country ranks fourth in the world for bauxite output. Bauxite ore reservoirs can be found in states like Odisha, Gujarat, Jharkhand, Chhattisgarh, Maharashtra, Karnataka, and Tamilnadu. Odisha is the leading bauxite producer among these states. Some of the major Indian firms that produce aluminum from the mineral bauxite include Hindalco, Balco, Malco, and Nalco. The amount of bauxite produced each year has gradually increased. The amount of bauxite produced in India between 2016 and 2017 was 25,212.35 thousand tones, demonstrating the country's bountiful bauxite output. Red mud is produced as a byproduct of the

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Bayer process. As a result, the output of waste residue red mud has increased. The amount of aluminum in the bauxite determines how much residual red mud is produced.
In the geotechnical industry, red mud is mixed with linear materials and employed. It has a high compressive strength while also lowering hydraulic conductivity. These positive outcomes strongly support the use of red mud in clay linear. The important titanium oxide presence and iron are recovered and used for various processes in the recovery of the elements found in the red mud. Waste materials generated by many sectors are hostile to the environment, but they are thought to be good candidates for the adsorption process and hence can be put to good use. Red mud is a potential substance for removing dyes such as Rhodamine B, Methylene blue, Congo red and phenolic contaminants from wastewater. Red mud was used to efficiently treat inorganic contaminants such as phosphate, fluoride, and nitrate. In the subject of heavy metal removal from wastewater, red mud can be used as a possible material, and the method involved is simple. Red mud was used as an adsorbent to successfully extract metals such as copper, nickel, cadmium, and zinc.

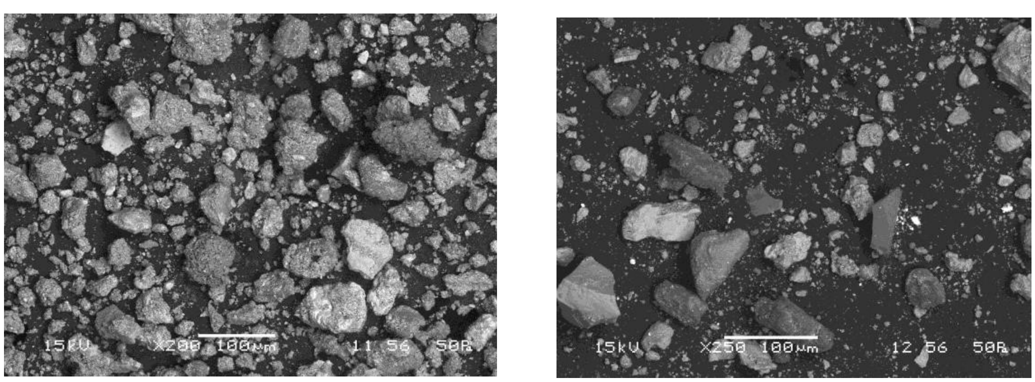
2. Methodology

A computational approach and an experimental investigation of red mud are both included in the current work. Red mud is being studied for its morphological, chemical, mineralogical, and geotechnical properties, and a model footing test using the mud as a subgrade material is being used as part of the experimental approach. Model footings lying on red mud are subjected to finite element analysis as part of the numerical technique. Microanalysis of red mud particles is carried out using a scanning electron microscope (SEM) equipped with an EDX micro analyzer. "In accordance with IS:2720, the geotechnical characterisation of red mud was carried out. The X-ray diffraction (XRD) method is used to identify the mineral phase present in the red mud. mud." When comparing the results of the finite element analysis to those of a laboratory model test, researchers used the commercial programme PLAXIS.

3. Result and Discussion

3.1 Morphology, Chemistry and Mineralogy of Red Mud

Figures 1 and 2 show a red mud scanning electron micrograph (a). Red mud comprises irregular, agglomerated, and spherical particles of various sizes, as can be seen in the image. If you know that red mud is acidic, you may want to look at the particle shape following acid treatment. As may be seen in Figure 1, an electron scanning photomicrograph shows the acid-treated red mud (b).



(a) (b)

Fig 1. (a) Scanning electron photomicrograph at 200 magnifications, (b)Scanning electron micrograph of acid washed red mud at 250 times magnifications.

Untreated red mud (Figure 1a) has agglomerated particles, which are absent here. The particles have no surface roughness at all. This suggests that the red mud's alkali ingredient is to blame for its aggregation.

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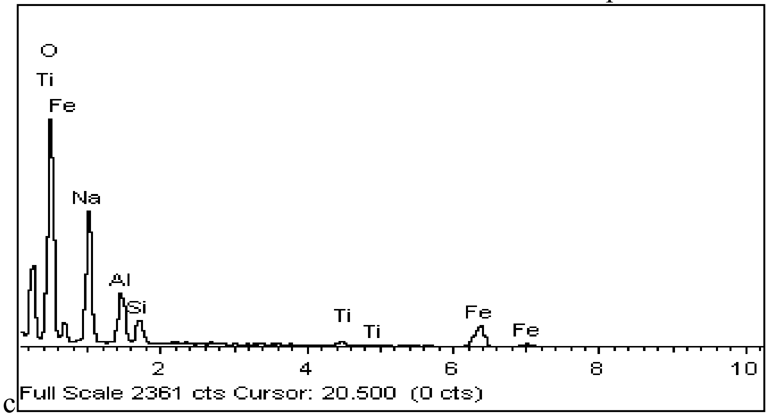
EDX analysis has been used to investigate the red mud's particle chemistry. As shown in Table 1, the EDX analysis of red mud is displayed in Figure 2 and the proportion of each element by weight is indicated. Sodium and iron were discovered to be prominent in the surface chemistry.



c

Fig 2. EDX analysis of red mud.

Table 1. Percentage (by weight) of chemicals present in red mud.

Element	**O**	**Na**	**Al**	**Si**	**Ti**	**Fe**	**Total**
Element percentage by weight	46.70	23.98	7.74	3.65	1.07	16.86	100

Hematite, gibbsite, goethite, and sodalite are some of the primary minerals in red mud, which is depicted in Figure 3 of the mineralogy of the red mud.

"The pH value may reveal a lot about a substance's chemistry as a whole. This is why the pH value of the red mud was tested and found to be 11.4 which indicates that red mud is strongly alkaline in nature."

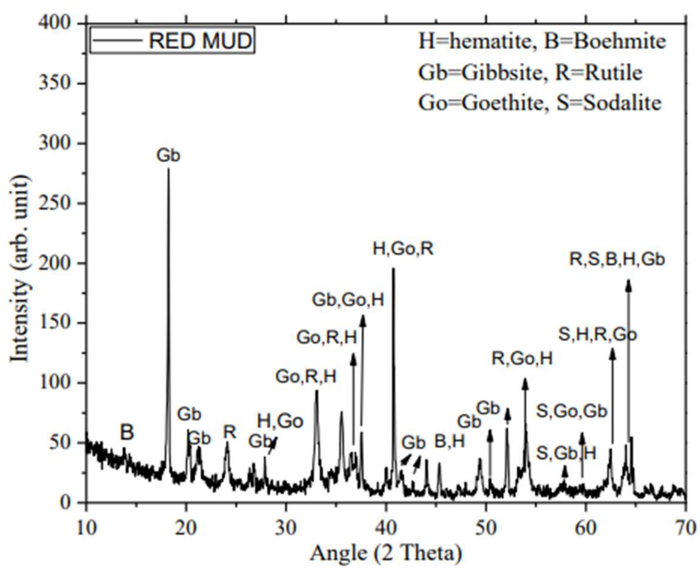


Figure 4. XRD analysis of red mud.

Conclusion

Based on laboratory geotechnical study, model footing test, and FE analysis, this work discusses the probable use of red mud as a subgrade building material. Based on the results of these experimental and numerical studies and debates, the following conclusion may be drawn: A higher specific gravity

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than soil is attributed to the red mud's high concentration of iron-compound minerals. Due to its high specific gravity, red mud has a greater MDD than other materials. The dispersiveness test showed that red mud is very dispersive, necessitating a soil cover on top to guard against external weathering. The pavement with a soil layer on top has a greater carrying capability, according to this research.

References

1. Rout, S. K., Sahoo, T. and Das, S. K., Utility of red mud as an embankment material, *International Journal of Earth Science and Engineering,* Vol. 05 (6), 2012, pp.1645-1651.
2. Parlikar, U. V., Saha, P. K. and Khadilkar, S. A., Technological options for effective utilization of bauxite residue (Red mud) - A review, *International Seminar on Bauxite Residue (Red Mud)*, 2011, Goa, India.
3. Bhaskar, M., Akhtar, S. and Batham, G., Development of the Bricks from Red Mud by Industrial Waste (Red Mud), *International Journal of Emerging Scienceand Engineering*, Vol. 2 (4), 2014, pp.7-12.
4. Singh, A. P., Singh, P. C. and Singh, V. N., Cyclohexanethiol separation from kerosene oil by red mud, *J. Chem. Technol. Biotechnology*., Vol. 56 (2), 1993, pp.167-174.
5. Mishra, B., Staley, A. and Kirkipatrick, D., Recovery of value added products from red mud, *Minerals and Metallurgical processing*, Vol. 19, 2002, pp.87-94.
6. Wang, S., Boyjoo, Y., Choueib, A. and Zhu, Z. H., Removal of dyes from aqueous solution using fly ash and red mud, *Water Research*, Vol. 39, 2005, pp.129-138.
7. Zhang, Jizhe & Liu, Shengjie & Yao, Zhanyong & Wu, Shaopeng & Jiang, Hongguang & Liang, Ming & Qiao, Yaning. (2018). Environmental aspects and pavement properties of red mud waste as the replacement of mineral filler in asphalt mixture. Construction and Building Materials. 180. 605-613. 10.1016/j.conbuildmat.2018.05.268.
8. Sahu, Manoj & Patel, Rajkishore. (2016). Methods for Utilization of Red Mud and Its Management. 10.1016/B978-0-12-803837-6.00019-6.
9. Dodoo Arhin, David & Nuamah, Rania & Agyei-Tuffour, Benjamin & Obada, David & Yaya, Abu. (2017). Awaso Bauxite Red Mud-Cement Based Composites: Characterisation for Pavement Applications. Case Studies in Construction Materials. 7. 10.1016/j.cscm.2017.05.003.
10. Siverio Lima, Mayara & Thives, Liseane. (2020). Mechanical feasibility of using red mud as filler in asphalt mixtures to improve permanent deformation. TRANSPORTES. 28. 1-13. 10.14295/transportes.v28i2.1847.
11. Chandra, Sarath & S, Krishnaiah & Sahile, Kibebe. (2021). Utilization of Red Mud-Fly Ash Reinforced with Cement in Road Construction Applications. Advances in Materials Science and Engineering. 2021. 10.1155/2021/3728652.