www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 01, January 2025, pp : 820-821

e-ISSN : 2583-1062
Impact Factor : 7.001

ADVANCED UTILIZATION OF INDUSTRIAL WASTE RESIDUALS: RED MUD AND CKD FOR SUSTAINABLE PAVEMENT

Kundan Kumar[1], Afzal Khan[2]

[1,2]Department Of Civil Engineering Millennium Institute Of Technology Bhopal M.P, India.

ABSTRACT

Industrial waste management is a pressing concern globally, and this research explores the potential reuse of Red Mud (a steel industry by-product) and Cement Kiln Dust (CKD, a cement industry waste product) in pavement construction. The study evaluates the geotechnical properties of cohesionless soil mixed with varying proportions of Red Mud and CKD. Experimental investigations, including grain size analysis, permeability, compaction, California Bearing Ratio (CBR), and Direct Shear tests, indicate that the mix containing 70% cohesionless soil, 30% Red Mud, and 25% CKD is optimal for subgrade construction. The research not only offers an innovative solution to waste disposal but also enhances the strength and durability of pavements.

Keywords: Red Mud, Cement Kiln Dust (CKD), Cohesionless Soil, Pavement Stabilization, Industrial Waste Utilization, Soil Reinforcement

1. INTRODUCTION

1.1 Background

Red Mud, a by-product of the steel industry, and CKD, a waste material from cement production, pose significant environmental challenges. The disposal of these materials requires extensive land resources, contributing to economic and ecological concerns. India generates approximately 90 million tonnes of Red Mud annually and significant amounts of CKD, which often lead to environmental hazards due to their alkaline properties.

1.2 Objectives

The primary objectives of this study are:

1. To evaluate the permeability of cohesionless soil mixed with CKD and Red Mud.
2. To determine the maximum dry density (MDD) and optimum moisture content (OMC) for different mix proportions.
3. To analyze the load-bearing capacity through California Bearing Ratio (CBR) tests.
4. To assess shear strength parameters using Direct Shear Tests.

2. MATERIALS AND METHODS

2.1 Materials

1. Red Mud: Procured from the steel industry, it primarily contains Fe_2O_3, Al_2O_3, and TiO_2, with significant environmental hazards due to its high alkalinity.
2. Cement Kiln Dust (CKD): Collected from Jai Industries, Jammu & Kashmir, CKD possesses pozzolanic properties and serves as an effective stabilizer.
3. Cohesionless Soil: The base material used for stabilization.

2.2 Methodology

2.2.1 Grain Size Analysis

Sieve analysis was performed to classify the soil type and determine particle size distribution.

2.2.2 Permeability Testing

Constant head permeability tests measured the flow characteristics of soil mixed with Red Mud and CKD.

2.2.3 Compaction Tests

Standard Proctor tests determined the MDD and OMC of various soil mixes.

2.2.4 California Bearing Ratio (CBR) Tests

CBR tests assessed the load-bearing capacity of mixes, critical for subgrade evaluation.

2.2.5 Direct Shear Tests

Shear strength parameters (cohesion and internal friction angle) were evaluated using direct shear tests.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 01, January 2025, pp : 820-821

e-ISSN : 2583-1062
Impact Factor : 7.001

3. RESULTS AND DISCUSSION

3.1 Permeability

The permeability of cohesionless soil decreased with the addition of Red Mud and CKD. For a mix of 70% cohesionless soil, 30% Red Mud, and 25% CKD, permeability was reduced significantly to 0.0029 cm/s, indicating improved soil stability.

3.2 Compaction Characteristics

The MDD and OMC for the optimal mix were 0.84 g/cc and 20%, respectively. This represents a 29% increase in dry density compared to pure sand.

3.3 Load-Bearing Capacity

The CBR value for the optimal mix (70% cohesionless soil, 30% Red Mud, and 25% CKD) was 219.8%, significantly higher than the base mix (24.8%). This highlights the enhanced load-bearing potential of the stabilized soil.

3.4 Shear Strength

The addition of CKD and Red Mud increased the cohesion and internal friction angle. For the optimal mix, cohesion increased to 6.67 kN/m², and the internal friction angle reached 40.36°, resulting in superior shear strength.

4. CONCLUSION

1. The integration of Red Mud and CKD with cohesionless soil reduces permeability and enhances geotechnical properties.

2. The optimal mix (70% cohesionless soil, 30% Red Mud, and 25% CKD) achieves the highest MDD and CBR values, making it ideal for subgrade applications.

3. Utilizing industrial waste for pavement stabilization addresses waste disposal challenges and promotes sustainable construction practices.

5. SCOPE FOR FUTURE WORK

1. Investigating the long-term durability of Red Mud and CKD-stabilized pavements.

2. Exploring the environmental impact of using these materials on a large scale.

3. Expanding applications to other types of construction, such as embankments and retaining walls.

6. REFERENCES

[1] Kumar, A., Gupta, D. (2015). Behavior of cement-stabilized fiber-reinforced soil mixtures. Geotextiles and Geomembranes, 44(3), 466-474.

[2] Patil, B.M., Patil, K.A. (2013). Effect of Pond Ash and RBI Grade 81 on subgrade properties. International Journal of Civil Engineering, 7(12), 966-971.

[3] Sariosseiri, F., Razavi, M. (2011). Stabilization of soil with Portland cement and CKD. Geo-Frontiers, 3(1), 778-787.