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STUDY ON USE OF RECYCLED ASPHALT PAVEMENTIN SOIL STABILISATION

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Abstract.

Black cotton soil poses challenges in construction due to its expansive nature, limited bearing capacity, and vulnerability to volumetric reform, causing uneven settling and cracking. This impacts infrastructure, especially in rural development where road construction is essential. The California Bearing Ratio (CBR) is a crucial factor in rural road design on expansive soil. Typically, additional macadam layers are recommended, but local material availability can increase construction costs. Soil stabilization becomes a cost-effective solution, modifying geotechnical properties for strength, stability, and durability. Expansive soils, like black cotton soil, are particularly suitable for stabilization. India faces challenges with industrial waste causing environmental hazards. Stabilizing soil with industrial waste is a sustainable approach. A strong road network is vital for economic growth, but weaknesses in subgrade, infiltration capacity, landslides, and environmental concerns can hinder effectiveness. Recycled asphalt, a popular eco-friendly material, was studied for its impact on black cotton soil. Treating the soil with varying percentages of Recycled asphalt pavement Pavement (RAP) was found to yield optimal strength, making it suitable for low-traffic road sub-bases.In a practical application, Madikeri soil prone to road collapse was stabilized using RAP, with tests including grading, CBR, specific gravity, Atterberg's limits, and modified Proctor compaction. The study recommends incorporating 25% RAP for improved penetration resistance, presenting a potential method for stabilizing subgrade soil, balancing environmental preservation with cost considerations.

Keywords: Soil Stabilization, Expansive Soil, Recycled Asphalt Pavement (RAP), Rural Road Construction

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Introduction

Globally prevalent soils, especially black cotton soil, cover a substantial portion of India's total area, contributing to its low load-bearing capacity due to high water absorption. The characteristic swelling and shrinking of black cotton soil pose significant challenges in construction, particularly in road building, leading to deformation and uneven surfaces.India, with the world's second-largest road network, generates considerable recycled asphalt pavementpavement (RAP) during routine maintenance. While a significant portion is recycled, the remainder often ends up in landfills, raising environmental concerns. The increasing use of RAP in India provides cost savings, efficient resource utilization, and environmental benefits by extending pavement material life and reducing carbon footprints.Soil stabilization is a crucial technique for enhancing the strength of weak soils like black cotton soil. The focus is on modifying geotechnical properties to control swelling, shrinking, and increase soil strength and durability. Expansive clayey soil is particularly suitable for stabilization due to its particle shape. Stabilization is a cost-effective approach that transforms weak soil into a valuable construction material, maintaining desired strength in road pavement layers and preventing issues like fatigue cracking and permanent deformation.Recent studies highlight the efficacy of combustion residues with pozzolanic qualities in stabilizing expansive soils. However, the challenge lies in the proper disposal of industrial by-products, considering potential environmental impacts. Efforts should explore utilizing low-cost, locally available industrial by-products to align with sustainable and environmentally friendly construction practices, meeting geotechnical engineering standards for weak soil.

2. Methodology

This research aims to explore how adding hydrated lime and industrial by-products can make soil stronger. The chapter explains the materials used, how the samples were combined, and the testing methods. We got black cotton soil, which is a type of clay, and tested it in the lab. We did different tests, like Sieve Analysis, Atterberg Limits, Differential Swell Test, and California Bearing Ratio (CBR). We also took recycled asphalt pavement (RAP), dried and crushed it, and mixed it with the

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black cotton soil in different amounts. Then, we did a lot of tests on these mixtures to check things like weight, moisture, asphalt content, and strength.

We used Sieve Analysis to see the sizes of particles in the soil. Tests for liquid limit, plastic limit, and shrinkage limit helped us understand how the soil behaves with different moisture levels. The Standard Proctor Test showed us how moisture and soil density are related, helping us know the best moisture levels for packing the soil. The Unconfined Compression Test checked how strong the soil is with the right moisture. We also checked the CBR values for different RAP amounts to see how well the soil can carry weight in different situations.We used statistical models with SPSS to make connections between soil strength (UCS) and CBR values and soil qualities. The correlation coefficient (R2) helped us see how reliable these models are. This approach gives us a good way to study the physical and mechanical properties of soil made stronger with hydrated lime and industrial by-products. This information is useful for building and road projects.

Results and Discussion

The test results obtained on the characteristics of the subgrade soil are tabulated below.

Properties of Subgrade Soil

Parameters	Results
Specific Gravity	2.3
Liquid Limit (%)	39.2
Plastic Limit	Nil
Optimum Moisture Content (%)	15.03
Maximum Dry Density (g/cc)	1.92
Maximum Bulk Density (g/cc)	2.21

Test Results of Modified Proctor Compaction

Particulars	MDD (g/cc)	OMC (%)
Subgrade Soil + 0% RAP	1.92	15.03
Subgrade Soil + 5% RAP	1.79	16.95
Subgrade Soil + 10% RAP	1.84	16.73
Subgrade Soil + 15% RAP	1.85	17.65
Subgrade Soil + 20% RAP	1.86	17.26
Subgrade Soil + 25% RAP	1.95	15.09

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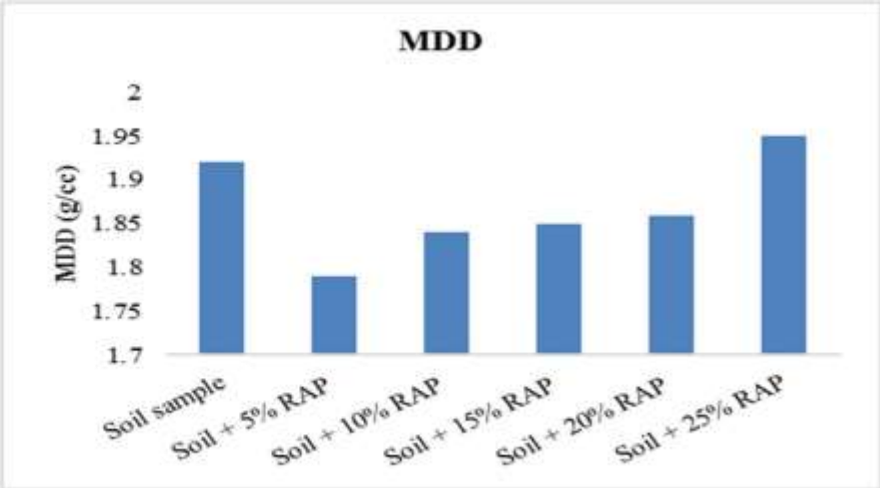

Particulars	CBR at 2.5mm penetration (%)	CBR at 5mm penetration (%)	CBR at 7.5mm penetration (%)	CBR at 10mm penetration (%)
Subgrade Soil + 0% RAP	2.8	4.81	6.91	8.14
Subgrade Soil + 5% RAP	5.6	8.55	10.89	12.46
Subgrade Soil + 10% RAP	7.01	11.11	14.15	16.17
Subgrade Soil + 15% RAP	8.24	13.37	16.75	31.47
Subgrade Soil + 20% RAP	9.47	15.48	18.51	21.75
Subgrade Soil + 25% RAP	9.84	15.87	20.37	23.02

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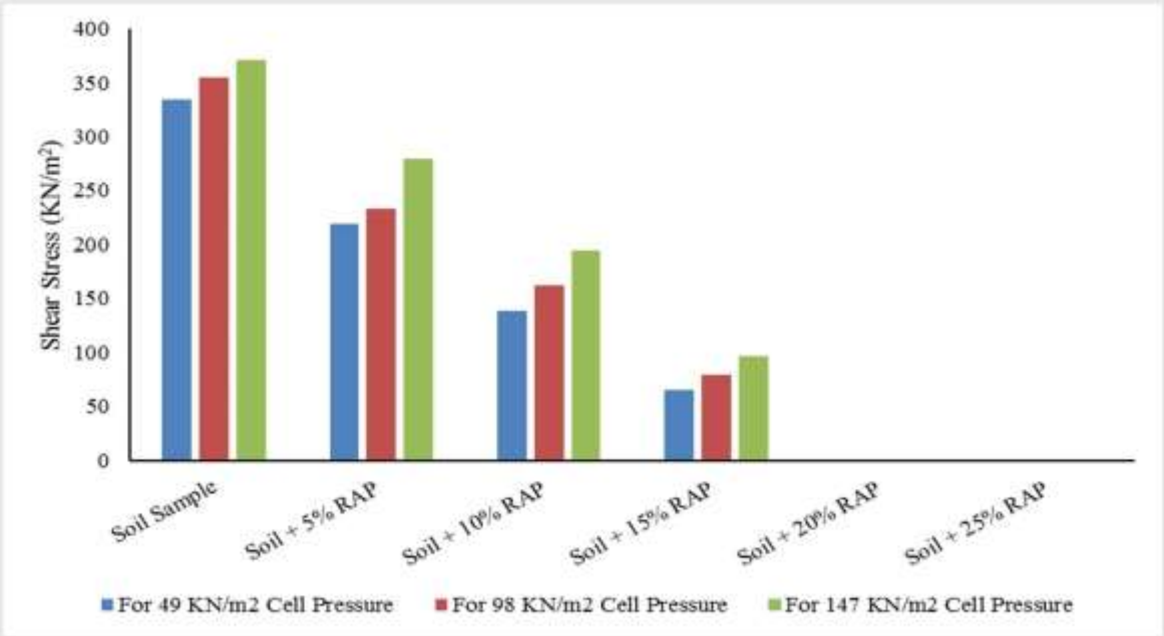

Variations in shear stress

Conclusions

Several studies have confirmed the effectiveness of Recycled asphalt pavementPavement (RAP), Silica Fume Coal Bottom Ash (SCBA), and Ground Granulated Blast Furnace Slag (GGBFS) in addressing challenges posed by black cotton soil. Experimental work, microstructure analysis, and statistical modeling support these findings. The study notes that the addition of RAP increases density and stability, while higher RAP content can decrease shear stress due to crack formation from larger particle sizes (20mm). Smaller RAP materials are recommended for shear-induced pavement collapse. Higher RAP content also enhances the bearing capacity of failing pavements under load. While these conclusions are applicable to subgrade soil and RAP, the study emphasizes considering the unique qualities of different soil types and RAP.The research suggests using black cotton soil stabilized with RAP as a sub-base material for lightly trafficked roads, with an emphasis on preventing water infiltration for sustained strength. The study underscores the importance of the alkaline environment required for the pozzolanic process, achieved with the addition of 6% lime. The incorporation of RAP, SCBA, and GGBFS reduces the liquid limit, indicating enhanced free calcium ions and a thinner double diffuse layer. This process creates a flocculated structure, leading to a 10% reduction in the liquid limit. Particle size variations contribute to a decrease in the plasticity index and

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swelling behaviourist curing age, the study observes a significant increase in Unconfined Compressive Strength (UCS) for RAP, SCBA, and GGBFS compositions. California Bearing Ratio (CBR) values also rise with higher RAP, SCBA, and GGBFS content. RAP-blended samples outperform SCBA and GGBFS blends in terms of UCS and CBR values. The study concludes that RAP is a superior stabilizer for black cotton soil, providing enhancements in Atterberg limits, differential free swell, compaction, unconfined compressive strength, and CBR.

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