Experimental Investigation on Strength Improvement of Soft Subgrade Soil Using Hydrated Lime and Coir Fiber

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***Abstract*—Soft subgrade soils exhibit poor engineering properties such as low bearing capacity, high compressibility, and excessive swelling behavior. These deficiencies reduce pavement performance and increase maintenance cost. In the present investigation, an attempt was made to improve the strength characteristics of soft subgrade soil using hydrated lime, Ground Granulated Blast Furnace Slag (GGBS), and coir fiber reinforcement. Laboratory tests including Free Swell Index, Atterberg Limits, Standard Proctor Test, California Bearing Ratio (CBR), and Unconfined Compression Test were conducted on untreated and treated soil samples. Experimental results indicated that the addition of hydrated lime and coir fiber significantly improved the engineering behavior of soil. The optimum coir fiber content increased the CBR value considerably and enhanced the load carrying capacity of stabilized soil. The proposed stabilization method is economical, eco-friendly, and suitable for pavement subgrade applications.**

***Index Terms*—CBR, Coir Fiber, GGBS, Hydrated Lime, Soil Stabilization, Subgrade Soil.**

I. INTRODUCTION

Soft subgrade soils are highly problematic in pavement construction due to their low strength and high swelling properties. These soils exhibit excessive settlement and poor load carrying capacity, which results in premature pavement failures. Soil stabilization techniques are commonly adopted to improve engineering properties and ensure long-term pavement performance.

The utilization of industrial by-products and natural fibers in stabilization has gained considerable importance in recent years. Hydrated lime effectively reduces plasticity and swelling characteristics of expansive soils, while GGBS acts as a cementitious material. Coir fiber improves tensile strength and ductility of soil. This study focuses on evaluating the combined effect of hydrated lime, GGBS, and coir fiber on the stabilization of soft subgrade soil.

II. LITERATURE REVIEW

Several researchers have investigated the effectiveness of chemical stabilizers and natural fibers in soil stabilization. Previous studies concluded that hydrated lime significantly improves the plasticity and bearing capacity of expansive soils. Researchers also reported that fiber reinforcement enhances ductility and resistance against cracking.
Studies on coir fiber reinforced soils demonstrated improvements in shear strength, CBR value, and compaction characteristics. GGBS has also been widely used as a supplementary stabilizing material due to its pozzolanic properties and environmental benefits.

III. MATERIALS USED

The soft clay soil used in this study was collected from Karamchedu village near Chirala. Hydrated lime was used as the primary chemical stabilizer. GGBS was incorporated as a supplementary cementitious material, while coir fiber was used as reinforcement material due to its biodegradable nature and good tensile properties.
The soil exhibited high swelling behavior with Free Swell Index greater than 100%. The liquid limit and plasticity index indicated that the soil belonged to highly expansive category as per IS classification.

Table I: Properties Of Soil

Property	Value	Remarks
Liquid Limit (%)	54	High Plasticity
Plasticity Index (%)	25.43	Expansive Soil
MDD (g/cc)	1.97	Low Density
OMC (%)	11.9	Optimum
CBR Value (%)	2.13	Poor Subgrade

IV. EXPERIMENTAL METHODOLOGY

Laboratory investigations were carried out in accordance with IS 2720 standards. Free Swell Index, Atterberg Limits, Standard Proctor Test, CBR Test, and UCC Test were conducted on untreated and treated soil samples. Hydrated lime content was varied from 3% to 15%, while coir fiber content was varied from 0.2% to 2.0%.

The stabilized soil samples were prepared at optimum moisture content corresponding to maximum dry density. Experimental observations were recorded and compared with untreated soil.

Table Ii: Cbr Results for Different Fiber Content

Fiber Content (%)	CBR Value (%)	Observation
0	2.13	Poor
0.4	3.25	Improved
0.8	4.65	Good
1.2	5.82	Maximum
1.6	5.10	Reduced
2.0	4.48	Reduction

V. RESULTS AND DISCUSSION

The experimental results revealed significant improvement in engineering properties of soil after stabilization. The addition of hydrated lime reduced plasticity and swelling characteristics. GGBS improved the density and bonding characteristics of stabilized soil.

The inclusion of coir fiber increased the CBR value and enhanced resistance against deformation. The optimum fiber content was observed at 1.2%, where maximum strength improvement was achieved. Beyond optimum dosage, reduction in strength was noticed due to improper dispersion of fibers.

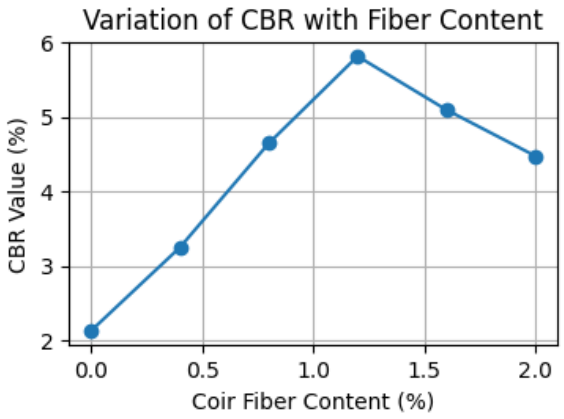

Fig.1 Variation of CBR with Fiber Content

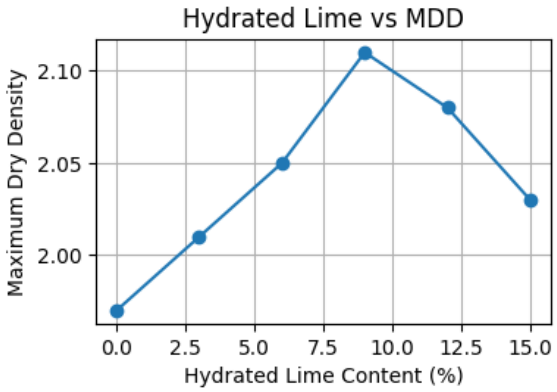

Fig.2 Hydrated Lime vs Maximum Dry Density

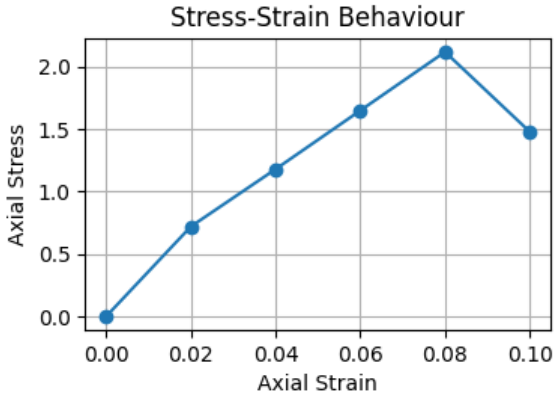

Fig.3 Stress-Strain Behavior

VI. CONCLUSION

The present study concludes that hydrated lime, GGBS, and coir fiber can effectively improve the engineering properties of soft subgrade soil. The stabilized soil exhibited increased CBR value,

improved compaction characteristics, and better strength behavior compared to untreated soil. The optimum coir fiber content was found to be 1.2%. The proposed stabilization technique is eco-friendly, economical, and suitable for pavement applications. Future studies may focus on long-term field performance and durability analysis of stabilized soil.

REFERENCES

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