Stabilization of Expansive Soil Using Fly Ash And Stone Dust: A Regional Study of South Gujarat

Nisarg Patel[1], Javal Patel[2], Utsav Patel[3]
[1, 2, 3] Dept of Civil Engineering

Abstract- *Expansive (black cotton) soils pose serious challenges to civil engineering structures due to their high swelling and shrinkage behavior. This study focuses on stabilizing such soils using fly ash and stone dust as economical and sustainable materials. Various proportions of fly ash (5%, 10%, 15%) and stone dust (10%, 20%, 30%) were added to the soil.*

Laboratory tests including Standard Proctor test, Atterberg limits, and shear strength tests were conducted. The results showed an increase in Maximum Dry Density from 1589.65 kg/m³ to 1842.89 kg/m³ and a decrease in Optimum Moisture Content from 21.97% to 16.23%. The liquid limit and plastic limit were significantly reduced, and shear strength increased from 124.86 kPa to 412.28 kPa.

The study concludes that the optimum mix of 15% fly ash and 30% stone dust effectively improves soil properties, making it suitable for construction applications.

Keywords: Expansive soil, black cotton soil, soil stabilization, fly ash, stone dust, and shear strength.

I. INTRODUCTION

Expansive soils, particularly black cotton soils, are widely found in regions such as South Gujarat and are known for their high swelling and shrinkage characteristics due to changes in moisture content. These volume changes cause serious problems in civil engineering structures, including cracks in pavements, foundation instability, and reduced load-bearing capacity. To address these issues, soil stabilization techniques are used to improve the engineering properties of such soils. In recent years, the use of industrial by-products like fly ash and construction waste such as stone dust has gained attention due to their cost- effectiveness and environmental benefits. Flyash improves soil strength through pozzolanic reactions, while stone dust enhances compaction and reduces plasticity. This study aims to investigate the combined effect of fly ash and stone dust on expansive soil by conducting various laboratory tests and determining the optimum mix proportion for improved performance in construction applications.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The initial step of this study involves identifying the problems associated with expansive (black cotton) soil, which exhibits high swelling and shrinkage behavior leading to structural instability and damage. In regions like South Gujarat, such soils pose challenges for construction due to low strength and poor load-bearing capacity. To address this issue, research was conducted by reviewing journals, research papers, and previous studies related to soil stabilization techniques. The focus was on the use of economical and sustainable materials such as fly ash and stone dust. Based on the collected information, the idea was developed to utilize these materials in varying proportions to improve the engineering properties of soil. Relevant data on material characteristics, mix design, and testing methods were gathered to form a proper experimental approach for the study.

III. STUDIES AND FINDING

The experimental study was carried out to evaluate the effect of fly ash and stone dust on the engineering properties of expansive (black cotton) soil. Various laboratory tests were conducted on both untreated and treated soil samples with different proportions of fly ash (5%, 10%, 15%) and stone dust (10%, 20%, 30%).

The results showed a significant improvement in soil properties with the addition of these stabilizing materials. The Maximum Dry Density (MDD) increased from 1589.65 kg/m³ to 1842.89 kg/m³, indicating better compaction characteristics. At the same time, the Optimum Moisture Content (OMC) decreased from 21.97% to 16.23%, which reflects improved workability of the soil.

The Atterberg limits also showed considerable reduction. The liquid limit decreased from 87% to 44.7%, and the plastic limit reduced from 38.29% to 24.48%, indicating a decrease in plasticity and swelling behavior. Additionally, the shear strength of the soil improved significantly from 124.86 kPa to 412.28 kPa, demonstrating enhanced load-bearing capacity. From the overall observations, it was found that the combination of 15% fly ash and 30% stone dust gives the best results in terms of strength and stability. Thus, the study confirms that the use of fly ash and stone dust is an effective method for stabilizing expansive soils.

IV. GET PEER REVIEW

After completing the experimental work and analysis, the study was presented to peers, faculty members, and subject experts for review and feedback. The purpose of peer review was to evaluate the accuracy, clarity, and reliability of the research work, as well as to identify any possible improvements.

During the review process, valuable suggestions were received regarding the methodology, data presentation, and interpretation of results. Experts recommended improving the graphical representation of results, ensuring proper comparison between treated and untreated soil, and maintaining clarity in conclusions. Feedback was also given on correcting minor errors and enhancing the overall structure of the report.

The comments and suggestions provided by reviewers were carefully considered and incorporated into the study. This process helped in refining the research work, improving its quality, and ensuring that the findings are accurate and well-presented.

Thus, peer review played an important role in validating the study and enhancing its overall effectiveness.

V. IMPROVEMENT AS PER REVIEWER COMMENT

Based on the feedback received during the peer review process, several improvements were made to enhance the quality and clarity of the study. The methodology section was revised to provide a more detailed explanation of the experimental procedure and mix proportions. Additional emphasis was given to clearly presenting the testing standards and procedures followed during the laboratory work.

The results and discussion section was improved by including better comparisons between untreated and treated soil samples. Graphs and tables were refined to present data more clearly and effectively. Minor calculation and formatting errors identified by reviewers were corrected to ensure accuracy.

Furthermore, the conclusions were modified to more precisely reflect the findings of the study, highlighting the significance of the optimum mix proportion of fly ash and stone dust. Language and presentation were also improved for better readability and professional quality. These improvements helped in strengthening the overall research work and ensured that the study meets academic and technical standards.

VI. CONCLUSION

This study investigated the stabilization of expansive (black cotton) soil using fly ash and stone dust. The results clearly indicate that the addition of these materials significantly improves the engineering properties of the soil. The Maximum Dry Density increased while the Optimum Moisture Content decreased, showing better compaction characteristics.

The Atterberg limits were reduced considerably, indicating a decrease in plasticity and swelling behavior of the soil. Furthermore, a substantial increase in shear strength was observed, which enhances the load-bearing capacity and stability of the soil.

Among all the combinations tested, the mix containing 15% fly ash and 30% stone dust was found to be the most effective. This combination provided maximum strength and overall improvement in soil performance.

Thus, the use of fly ash and stone dust is an economical, eco-friendly, and efficient method for stabilizing expansive soils. It is highly suitable for applications in road construction, foundations, and other civil engineering works, especially in regions like South Gujarat.

VII. APPENDIX

The appendix includes additional data, calculations, and supporting information used in this study. It provides detailed laboratory results and observations that support the findings presented in the main report.

1. Laboratory Test Data

- Grain Size Analysis results
- Atterberg Limits (Liquid Limit, Plastic Limit) observations
- Standard Proctor Test data (MDD and OMC values)
- Shear Strength test results

2. Sample Calculations

- Calculation of Maximum Dry Density (MDD)
- Calculation of Optimum Moisture Content (OMC)
- Determination of Atterberg Limits
- Shear strength calculations

3. Mix Proportions

- Details of soil, fly ash, and stone dust combinations
- Percentage variations used in experiments

4. Graphs and Charts

- MDD vs OMC curves
- Variation of Liquid Limit and Plastic Limit
- Shear Strength variation graph

5. Photographs

- Soil sample collection
- Laboratory testing procedures
- Equipment used during experiments

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