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International Journal of Recent Advances in Engineering and Technology

ISSN: 2347-2812

Volume 14 Issue 01, 2025

A Review and Analysis of Expansive Soil: Materials and Stabilization Techniques

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Peer Review Information	Abstract
<p>Submission: 29 Jan 2025 Revision: 04 March 2025 Acceptance: 10 April 2025</p> <p>Keywords</p> <p>Expansive Soil Swelling Shrinkage Water Content Atterberg's Limits</p>	<p>The assessment and research in this work are centered on expansive soil behavior and management, which gift major demanding situations in civil engineering while there are volumetric adjustments because of fluctuations in the moisture content material. Expansive soils generally tend to swelling upon wetting and shrinkage while drying out, main to extensive volumetric adjustments that can cause extreme structural failure. The thing discusses several materials and techniques employed to counter the terrible impact of expansive soils on creation paintings. The dialogue consists of soil class, and trendy laboratory trying out strategies inclusive of Atterberg limits, shrinkage exams, and swell capability exams. Stabilization techniques with additives like lime, cement, fly ash, and polymer-based totally merchandise are also discussed. The take a look at additionally consists of recent geotechnical improvements for boosting expansive soil performance, inclusive of geo-grids, soil reinforcement, and new moisture control procedures. The paper concludes through outlining the limitations of current approaches and suggesting regions for similarly research to maximize the sustainability and efficiency of expansive soil control in production.</p>

INTRODUCTION

Expansive soils, or decrease-swell soils, are a form of soil that reports massive extent changes because of changes in moisture content material. The soils have a unique asset—expansion on wetting and contraction on drying—that can motive excessive troubles in engineering structures like foundation, roads, and pavements. The behavior of expansive soils relies upon on various of factors, along with mineral composition, clay content material and moisture content. The review and research of

expansive soils have emerged as a critical issue of geotechnical engineering to recognize their behavior and to reduce the danger posed through them.

The review is supposed to talk about the fabric and strategies concerned in comparing expansive soils. It incorporates an exhaustive discussion of laboratory testing techniques, including the Atterberg limits, compaction exams, and the swelling capacity tests, that are regularly applied to define those soils. The assessment additionally emphasizes numerous

stabilization methods, which includes the utilization of components like lime, cement, and fly-ash, to enhance expansive soil engineering properties. Through the analysis of the unique materials and techniques, the evaluation offers insights into how engineers can extra efficiently and sustainability layout solutions for resolving the troubles posed by expansive soils.

AIM & OBJECTIVES

AIM: The aim of this study is to provide a detailed review and study of expansive soil, focusing on their nature, behavior and

engineering properties of these soils and suggesting various stabilization techniques and mitigation strategies by using different materials to improve its properties.

OBJECTIVE: 1. To review and summarize the existing literature on expansive soil including materials, methods of stabilization and findings. 2. To analyze the characteristics and compare the effectiveness of different stabilization methods via physical and geotechnical methods and materials used to enhance the geotechnical properties of soil.

RESEARCH WROK

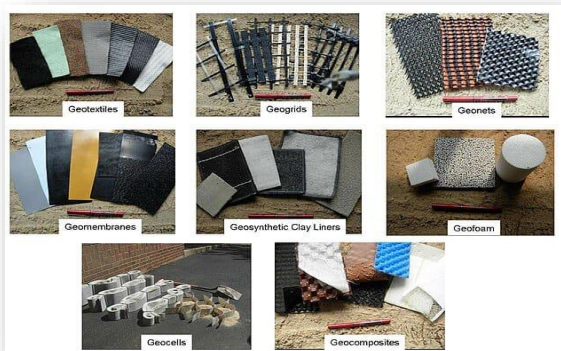
Summarized study of literature review

Paper title	Year of publication	Paper no.1	Author Name	Materials added	Methods used	Findings and conclusion
Study of swelling and shrinkage characteristics of expansive soil using silica gel as an admixture	April 2021	1	Uday A. Caudhari Vanshika Mucchhara	Silica Gel	Free Swell Index, standard proctor compaction test	Suitable Admixture to stabilize the soil, UCS value slightly increased by adding silica gel
Characterization of expansive soils for the foundation of an irrigation canal in the Peruvian Andes,Cabana-manazo case	2021	2	A Pilares - Hualpa, R Alfaro-Alejo, C A Pilares-Calla		Free expansion method, a swell index	Soil having high degree of expansion, which makes it highly dangerous with harmful effect and consequences for irrigation infrastructure
Effect of Geosynthetics on Swell Reduction during an Extreme rainfall Event	2023	3	Mohit Saily, Ivan Gratchev	Geosynthetics	CBR test, long term soil column test in which the effect of geosynthetics on vertical swell of soil	Geosynthetics does not improve the CBR of the saturated soil, reduction in swelling
Compaction and swelling behaviour of black cotton soil mixed with different non-cementitious materials	2017	4	Vikas Malik, Akash Priyadarshane	Fly ash, rice husk ash ,tyre waste', stone dust	SPT, swelling test	Addition of stone dust dosen't affect MDD significantly. Fly ash and rice husk reduces MDD. Decrease in heaving and swelling pressure is found due to addition of all the additives.
Sustainable soil stabilization of expansive soil subgrades through lime fly	August 2024	5	Tejashri Sambre , Mahesh Endait, Swati Patil	Lime and flyash	UCS, CBR Test, swell test	The mixture of lime-flyash can be used for soil stabilization & can be helpful for engineers and

ash admixtures						researchers in designing and constructing sustainable infrastructure.
Swelling properties of soils treated with chemicals and flyash	2014	6	G Radhakrishnan, Dr M Anjan Kumar and Dr GVR Prasada Raju	Magnesium chloride (MgCl ₂), Aluminum Chloride (AlCl ₃) and flyash	Free Swell Index as per IS2720(Part XL)-1977, Max Dry Density & OMC as per IS2720(Part 7&8)-1983, Swell Pressure Testing as per IS2720(Part XLI)-1977.	chemical and flyash combination is very effective in reducing the swell pressure, swell potential of the expansive soil considered.
Experimental behaviour of swell-shrink behaviour of expansive soil	June 2013	7	Sangita P. Lajurkar, Shantanu R. Khandeshwar, Rajesh M. Dhoble, Rashi G. Bade	Black cotton soil, bentonite and grey clay	Swelling test	A newly proposed parameter „Limiting Unit Shrink Potential“ appropriately characterizes the shrinking behaviour of expansive soil up to the transition zone, this “Unit Shrink Potential” has important relevance in predicting cyclic volumetric changes exhibited by any natural or manmade soil mass. Below the shrinkage limit there is a transition zone in which reduction in water content does not cause volume decrease.
Stabilization of expansive soil: A review	Feb 2024	8	Dharmendra Singh, Vijay Kumar and R.P. Tiwari	Lime, fly ash, coir fibre, Baggase ash	Mechanical Stabilization, Chemical Stabilization	Admixtures were used to stabilise expansive soil by stabilizing fly ash in expansive soil. The geotechnical properties of expansive soil may be improved by stabilization of expansive soil employing material.
Recent advances in expansive soil	July 2023	9	Umar Zada, Arshad Jamal,	Soil marble waste	Mechanical Stabilization, Chemical	The effectiveness of the material listed above has

stabilization using admixtures: current challenges and opportunities			Mudassir Iqbal, Sayed M. Eldin , Meshal Almoshaogeh, Souhila Rehab Bekkouche, Sultan Almuaythir	powder, fly ash, egg shell powder, stone waste, lime powder	Stabilization	previously demonstrated to be capable of stabilizing expansive soil and being environment friendly .
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SOME IMAGES OF MATERIALS & METHODS USED IN THE STUDY (SOURCE OF ALL IMAGES IS GOOGLE)



1. Geosynthetics



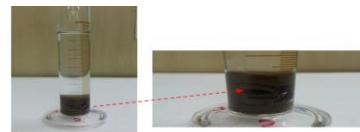
2. Silica Gel



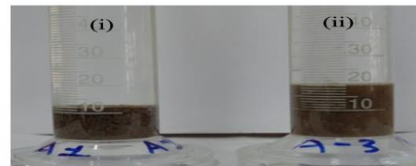
3. Expansive Soil



4. Egg Shell Powder



(a) Depiction of entrapped air pockets in swollen condition of soil specimens rapidly dried for the DSFS tests

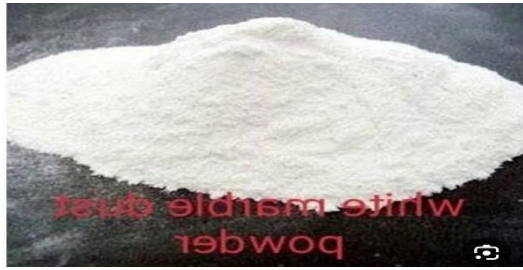


(b) Pictorial comparison of final swell of: (i) as-compacted, and (ii) desiccated Trichy soil – 2 specimens at a given placement condition

5. Free Swelling Method



6. Rice Husk



7. Marble Powder



8. Fly Ash

RESULTS

This research paper has provided a comprehensive review and study of expansive soils, highlighting their behavior, properties and stabilization methods. This study has contributed a detailed knowledge on expansive soil and has provided practical knowledge for the researchers working on these type of soil

CONCLUSION

Concluding remark from the above reviews that the various materials and methods for swelling soil stabilization presents a positive avenue for the sustainable construction practices. Various materials have been shown to improve the properties of soils by reducing its swelling property and improving strength.

FUTURE SCOPE

Future scope of review studies on expansive soil treatment could focus on developing sustainable and cost-effective stabilization method exploring the long-term performance of various treatments ultimately enhancing construction practices using various methods and materials in expansive soil

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