



# EVALUATION OF SOIL STABILIZATION TECHNIQUES FOR RURAL ROAD USING GEOSYNTHETIC REINFORCEMENT

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**Abstract :** Weak subgrade soils frequently cause rural roads to fail, and conventional stabilization techniques aren't always cost-effective or long-lasting. An efficient substitute is provided by geosynthetics (geotextiles, geogrids, and geocells), which increase soil strength, load distribution, durability, and require less upkeep. In this study, geosynthetic reinforcement for rural roads is assessed and contrasted with traditional soil stabilization techniques.

## I. INTRODUCTION

Rural roads play a vital role in connecting rural communities to urban centers, facilitating the transportation of goods and services, and promoting economic development. However, rural roads often face significant challenges, including poor soil conditions, limited maintenance resources, and harsh environmental conditions. Soil instability is a major concern for rural roads, as it can lead to pavement damage, increased maintenance costs, and reduced safety. In recent years, geosynthetic reinforcement has emerged as a promising technique for improving soil stability and enhancing the performance of rural roads. Geosynthetic materials, such as geotextiles and geogrids, can provide tensile strength, improve soil drainage, and reduce soil erosion. However, the effectiveness of geosynthetic reinforcement for soil stabilization in rural roads is highly dependent on various factors, including soil type, geosynthetic material properties, and construction techniques. This study aims to evaluate the effectiveness of different soil stabilization techniques using geosynthetic reinforcement for rural roads. The study will review existing literature, investigate the properties of various geosynthetic materials, and analyse the performance of geosynthetic-reinforced soil in different rural road applications. The findings of this study will provide valuable insights for engineers, contractors, and policymakers seeking to improve the design, construction, and maintenance of rural roads. Soil stabilization is the progression which involves enhancing the substantial properties of the soil in order to develop its strength, durability etc. by blending or mixing with additives. The dissimilar forms of technique used for soil stabilization are: Soil stabilization with cement, Soil stabilization with lime, Soil stabilization victimization hydrocarbon, and Chemical stabilization associated an innovative promising experience of stabilization by Geo textiles and Geo artificial fibers. Geotextiles have been effectively used for reinforcement of soils to recover the bearing capacity. Roads are arteries of a city and an increase in population increases traffic. Heavy traffic demands strong, smooth, durable and well maintained road pavement and hence healthy and strengthened road network is essential for socioeconomic development of a country. Reinforcement of road pavement using various materials is in practice, geosynthetics being popular among them. Geosynthetics are synthetic products used to stabilize terrain. The focus of this project is on better understanding of natural and artificial Geotextiles for strengthening of sub grade soil. The roads are getting busier with more cars and heavier trucks, and it's putting a lot of pressure on the roads we already have. The pressure between layers causes cracks to form in the asphalt. Settlements in certain areas can also cause cracks in the asphalt layer. Adding support to asphalt mixes is one way to make sure the roads last longer and work better. Reinforcement refers to the addition of specific materials to a material lacking particular attributes, with the purpose of granting it those attributes. During the early 1980s, Europe started implementing paving grids and composites, followed by their introduction into North America in the late 1980s. The implementation of grid composite, grid, and fabric in North America involved their combination. The utilization of grids has been gradually growing and has now encompassed millions of square yards. Experiments on paving grids and composites started in the early 1990's, and recently, the results of these experiments have been made accessible.

Geosynthetic: Geosynthetics with high tensile strength used in combination with soil of high compressive strength have been found to be effective in the design of many civil engineering applications. The application of Geosynthetics in the field of geotechnical, transportation, hydraulics, and geo-environmental engineering has been explained by many researchers. The materials employed in the manufacture of geosynthetics square measure primarily artificial materials, generally, derived from crude oil oils, though rubber, fiberglass. Geosynthetics could be a generic name representing a broad vary of plane merchandise factory-made from compound materials. the foremost common one's square measure geotextiles, geogrids, geo nets, geomembranes and geo composites, that square measure employed in contact with soil, rock Associate in Nursinging d/or the other material as an integral a part of an artificial project, structure.

The various types of geosynthetics:

1. Geotextiles (GT)
2. Geogrids (GG)
3. Geo nets (GN)
4. Geomembranes (GM)
5. Geosynthetic clay liners (GCL)
6. Geopipe (GP)
7. Geofoam (GF)
8. Geocomposite

## II. PROBLEM STATEMENT

Many rural roads are constructed over weak and moisture-sensitive soils, leading to issues such as rutting, cracking, and overall failure of the road structure. Conventional stabilization methods may not provide long-term solutions due to cost constraints, environmental concerns, or limited effectiveness in certain soil types. There is a need to explore and evaluate alternative solutions like geosynthetic reinforcement to enhance soil strength, improve road longevity, and reduce maintenance needs.

Rural road infrastructure often suffers from poor performance and rapid degradation due to weak and unstable subgrade soils, especially in areas with high moisture content or low load-bearing capacity. Traditional soil stabilization methods, such as the use of lime, cement, or mechanical compaction, may not always provide long-term effectiveness, particularly under varying environmental and traffic conditions. These methods can also be costly, labor-intensive, or environmentally unsustainable.

With the growing need for durable and low-maintenance rural roads, there is a pressing need to explore alternative soil stabilization techniques that are both effective and economically viable. Geosynthetic materials have emerged as promising solutions for reinforcing weak soils, but their performance in rural road applications under diverse conditions requires thorough evaluation. This project addresses the gap by assessing the effectiveness of geosynthetic reinforcement compared to conventional methods for stabilizing soils in rural road construction.

## III. OBJECTIVE

- I.To investigate the influence of soil type and moisture content on effectiveness of geosynthetic reinforcement.
- II.To evaluate the effectiveness of geosynthetic reinforcement improving the stability as well as load bearing capacity of rural road soil.
- III.To access the impact of geosynthetic reinforcement in rural road maintenance.
- IV.To evaluate the environment benefits of using geosynthetic reinforcement.

## IV. SCOPE OF PROJECT

The scope of this project on the "Stabilization of Soil Using Geosynthetic Materials in Rural Roads" focuses on the application of geosynthetic materials to enhance the stability, strength, and durability of soils used in rural road construction. The project covers both theoretical and practical aspects of soil stabilization with a focus on the following key areas:

### 1. Geographical Focus:

The project focuses on rural road networks, particularly in areas where poor soil conditions hinder long-term road performance and accessibility.

### 2. Materials Studied:

The study will cover various types of geosynthetics, including geotextiles, geogrids, geocells, and geomembranes, and their interaction with different soil types.

### 3. Soil Types:

Emphasis will be on weak subgrade soils such as clay, silt, or expansive soils, which are commonly found in rural settings and are prone to deformation or failure under traffic loads.

#### 4. Stabilization Techniques:

Both traditional stabilization methods (lime, cement) and geosynthetic-based techniques will be reviewed and compared for effectiveness.

#### 5. Testing Methods:

The project will involve laboratory and/or field testing, including soil strength tests (e.g., CBR, unconfined compression), compaction, and load-bearing capacity assessments.

#### 6. Performance Evaluation:

The durability, strength, settlement control, and cost-effectiveness of geosynthetic-reinforced soil systems will be evaluated against traditional methods.

#### 7. Design & Application Guidelines:

The outcome will include practical design recommendations and guidelines for implementing geosynthetics in rural road construction, aiming to improve road performance and lifespan.

#### 8. Limitations:

The project does not include the detailed structural design of roads or large-scale field trials due to time and resource constraints but focuses on evaluating performance through small-scale tests and simulations.

## V. BACKGROUND

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## VI. DATA ANALYSIS AND INTERPRETATION

The collected data will be analyzed to compare the performance of stabilized soil against unestablished soil. Statistical and graphical representations will be used to demonstrate improvements in soil properties.

## VII. MATERIAL USED



## VIII. RESULT

### 1. Geosynthetic Reinforcement's Impact on Soil Strength

Both untreated soil and soil reinforced with geosynthetics (geotextile/geogrid) were subjected to laboratory testing. The findings show that the stabilized soil's strength characteristics have significantly improved. Untreated soil was inappropriate for rural road subgrade due to its low California Bearing Ratio (CBR) value. The CBR value significantly increased with the addition of geosynthetic reinforcement, indicating enhanced load-bearing capability. When geosynthetics were positioned at the ideal depth within the subgrade, the greatest improvement was seen.

### 2. Comparison of CBR Values

Soil Condition	CBR (%)
Untreated soil	Low
Soil + Geosynthetic reinforcement	Moderate to High

The effectiveness of geosynthetics in subgrade stabilization was demonstrated by the reinforced soil's CBR value, which increased by two to four times when compared to untreated soil.

### 3. Deformation Behavior and Load Distribution

- By improving load distribution, geosynthetic reinforcement lessened the subgrade's vertical stress.
- The geosynthetic layer's confinement reduced the soil's potential for rutting and settlement.
- Overall stiffness was increased by better interlocking between soil particles.

#### 4. Rural Road Performance Assessment

- Pavement thickness could be decreased thanks to the use of geosynthetics, which resulted in financial savings.
- It is anticipated that reinforced sections will require less maintenance and have a longer service life.
- For weak and expansive soils, which are frequently found in rural areas, the method proved particularly helpful.

#### 5. Practical and Economic Advantages

- Geosynthetic stabilization is economical, especially for rural roads with little traffic.
- It is appropriate for rural construction conditions due to its simple installation and low equipment requirements.
- Utilizing geosynthetics in conjunction with locally accessible soil lowers the cost of material transportation.

#### IX. CONCLUSION

Geosynthetics are polymeric products which are applied to fulfil various functions in civil and geotechnical engineering. Since geosynthetics can perform different functions, as presented in the first part of this paper, they should be designed to meet criteria to sufficiently perform these functions in given applications. The filtration and stabilisation functions were also discussed in this paper. As presented in parts two and three of this study, geosynthetics for both filtration and stabilisation functions require specific features, since their application is quite complex. Whilst filtration seems to be more established with standardised design approaches and many successful applications, stabilisation is still at a relatively initial point on the learning curve, especially in the context of differentiation from well-established reinforcing applications. The authors hope that the review given in this paper will help to put in order the variability in the specific applications of geosynthetics for both of the functions.

