International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-10, Issue-07, Oct 2024

USE OF RBI GRADE 81 & SOLID WASTE ASH IN EXPANSIVE SOIL

Er. Ravneet Singh Sidhu, A.P, Bfcet, Bathinda,Punjab, ravneetsidhu.ce.bfcet@gmail.com

Er. Tanu, A.P (HOD, CE), Bfcet, Bathinda,Punjab, hod.ce.bfect@gmail.com

Er. Mandeep Kaur A.P, Bfcet, Bathinda,Punjab, Mandeep.bfcet.ce@gmail.com

Abstract - **The increase of population in the world has made good and cheap vehicular process, which requires good roads. Sub-base is primary portion of the road transmitting the stresses of the wheel load on the earth surface in such a way that it prevent damage of the road structure. The development of the new idea that enhancing geotechnical properties of the bottom soil is urgently needed. If the soil which is at the construction site or available in the area has not of good strength either take soil from another location. Hence, parameters like conductivity, stiffness, consistency, strength of local soil can be improved. Soil stabilization means to extent the quality of natural soil and provide adequate strength to the soil. It reduce permeability and safe from erosion**

The properties of soil will be changed according source wise, so strategy to soil's stabilization chosen as per parameters of localised soil. The engineering properties of soil can be decided in the lab. So all stabilization methods are used according to the physical properties of soil. In stabilization of soil, by mixing soil with other material we will alter the soil's characteristics in order to meet the purpose. The method of stabilization should be economical and does not influence the overall cost of project. Aim for current topic, the difference between the findings of Fly Ash with the dose of 0.01, 0.02%, 0.03%, 0.04%, and 0.06% and RBI Grade 81 with the dose of 1%, 2%, 3%, 4% and 6% to evaluate OMC-MDD, CBR and UCS of untreated and treated soil with RBI grade 81 on optimising data for curing period of one-three-ten days subsequently and same with ly Ash.

Keywords- CBR and UCS Optimization, Geotechnical Engineering, Fly ash, RBI Grade 81 Soil Strength Improvement, Soil Stabilization.

I. INTRODUCTION

Soil stabilization is an essential aspect of civil engineering, particularly in areas where the natural soil conditions do not meet the necessary strength and durability requirements for construction. Expansive soils, in particular, pose significant challenges due to their swell-shrink behavior. When subjected to moisture changes, these soils expand and contract, leading to severe damage to foundations, pavements, and other structures.

To address these issues, stabilizing agents such as RBI Grade 81 and fly ash are used to improve the geotechnical properties of expansive soils. RBI Grade 81 is a soil stabilizer known for its ability to enhance soil strength, reduce permeability, and improve load-bearing capacity. On the other hand, fly ash, a by-product of coal combustion, is widely used in stabilization due to its pozzolanic properties, which help improve soil strength over time.

This study aims to investigate the combined effects of RBI Grade 81 and fly ash on the stabilization of expansive soils. The research focuses on evaluating how these stabilizers influence key soil properties such as Optimum Moisture Content (OMC), Maximum Dry Density (MDD), and California Bearing Ratio (CBR). By analyzing different proportions of soil, fly ash, and RBI Grade 81, this study seeks to determine the optimal mix that can enhance soil performance for road construction and other civil engineering applications.

II. Literature Review:

Soil stabilization has been widely studied as a critical technique to improve the engineering properties of problematic soils, especially expansive soils. Expansive soils are notorious for their potential to swell when wet and shrink when dry, leading to damage in roads, foundations, and other civil infrastructure. Over the years, researchers have explored various chemical stabilizers, including lime, cement, fly ash, and more recently, RBI Grade 81, for

 DOI : 10.35291/2454-9150.2024.0397

mitigating the effects of such soils. electronically, find out if your editor prefers submissions on disk or as e-mail attachments.

RBI Grade 81 is a proprietary stabilizer that has shown promising results in increasing soil strength and reducing permeability. According to studies by Patil et al. (2016), RBI Grade 81 works by forming a cementitious matrix within the soil, which enhances its load-bearing capacity and reduces its shrink-swell potential. The stabilizer is particularly effective in improving the strength characteristics of soils in regions with high moisture content.

Fly ash, a by-product of coal-fired power plants, is another material widely used in soil stabilization. Its pozzolanic properties react with water and other chemicals to form cementitious compounds, thereby improving soil strength. Research by Dhanasekar et al. (2016) shows that fly ash, when combined with other stabilizers like lime or cement, significantly improves the California Bearing Ratio (CBR) and decreases the plasticity index of soils. The combination of fly ash and chemical stabilizers offers an eco-friendly solution for improving soil performance in construction.

However, the combined use of RBI Grade 81 and fly ash has not been extensively studied. While individual studies have shown the effectiveness of these materials, research addressing their combined impact on expansive soils is limited. This study aims to fill this gap by exploring the effect of both RBI Grade 81 and fly ash on expansive soils and determining the optimal mix ratio to achieve the best stabilization results.

III. Methodology:

The experimental methodology was designed to investigate the effects of RBI Grade 81 and fly ash on the stabilization of expansive soils. This section outlines the materials used, the sample preparation process, and the tests conducted to assess the geotechnical properties of the treated and untreated soil samples.

3.1 Materials:

- **Expansive Soil:** The soil used in this study was sourced from Shri Gomata Gayatri, Visakhapatnam, Andhra Pradesh. This region is known for expansive soil, which poses challenges for construction due to its high swelling and shrinkage properties.
- **Fly Ash:** Collected from a nearby thermal power plant, fly ash is a well-known industrial by-product used in soil stabilization for its pozzolanic properties.
- **RBI Grade 81:** A chemical stabilizer, RBI Grade 81 is widely used to improve soil strength and reduce permeability. It is available in powder form and was sourced from a local supplier.

3.2 Sample Preparation:

The soil samples were collected from a depth of 6-7 meters and air-dried for several days to achieve uniform moisture content. Once dry, the soil was sieved through a 4.75 mm sieve to remove large particles and organic matter. The samples were then mixed with varying proportions of fly ash and RBI Grade 81 to create different stabilization mixes.

3.3 Mix Proportions:

To assess the effects of different proportions of soil, fly ash, and RBI Grade 81, three mix combinations were prepared as shown in Table

Sr. No	Soil : fly ash : RBI
1	100:0:0
2	90:10:0
3	80:20:0
4	70:30:0
5	89:10:1
6	87:10:3
7	85:10:5

TABLE 1

3.4 Experimental Tests:

In this study, several laboratory tests were carried out to assess the engineering properties of expansive soils and to evaluate the effectiveness of RBI Grade 81 and fly ash as stabilizing agents. The following tests were performed:

3.4.1 Pycnometer Test (Specific Gravity):

The **Pycnometer Test** was conducted to determine the **specific gravity** of the soil samples. Specific gravity is a fundamental property that influences the behavior of soils in terms of compaction and strength. The test was performed using a pycnometer, which involves weighing the pycnometer with and without soil, both filled with water, and using the measured values to calculate specific gravity.

Figure 1 :Pycnometer Test

 DOI : 10.35291/2454-9150.2024.0397

ISSN : 2454-9150 Vol-10, Issue-07, Oct 2024

3.4.2 Liquid Limit Test (Casagrande Method):

The **Liquid Limit Test** was conducted using the Casagrande apparatus to determine the **liquid limit** of the soil, which is the moisture content at which soil changes from a plastic to a liquid state. The test involves placing a soil paste in a cup and cutting a groove. The liquid limit is the moisture content at which the groove in the soil closes after 25 blows of the Casagrande cup. This value is crucial for determining the soil's plasticity and potential for shrinkage and swelling.

3.4.3 Plastic Limit Test (Thread Rolling Method):

The **Plastic Limit Test** was conducted to find the **plastic limit**, which indicates the moisture content at which the soil transitions from a semi-solid to a plastic state. In this test, soil samples are rolled into threads of 3 mm diameter until they crumble. The plastic limit is the moisture content at which the soil begins to exhibit plastic behavior. The **Plasticity Index (PI)**, which indicates the soil's plasticity, is calculated as the difference between the liquid limit and plastic limit:

3.4.4 Standard Proctor Test (OMC and MDD):

The **Standard Proctor Test** was conducted to determine the **Optimum Moisture Content (OMC)** and **Maximum Dry Density (MDD)** for different soil mix proportions. In this test, the soil samples were compacted in a mold at different moisture levels. The MDD is the highest dry density that can be achieved for a specific moisture content, and the OMC is the moisture content at which this density is achieved. These values are key indicators of how the soil responds to compaction.

Figure 2: Standard Proctor Test

3.4.5 California Bearing Ratio (CBR) Test:

The **California Bearing Ratio (CBR) Test** was used to assess the strength and load-bearing capacity of the soil samples, both untreated and treated with RBI Grade 81 and fly ash. The CBR test measures the resistance of the soil to penetration, providing a percentage value that indicates the suitability of the soil for use in road subgrade layers. Higher CBR values represent stronger, more stable soil. The test results were compared for different mix proportions, with the highest CBR values indicating the most effective stabilization.

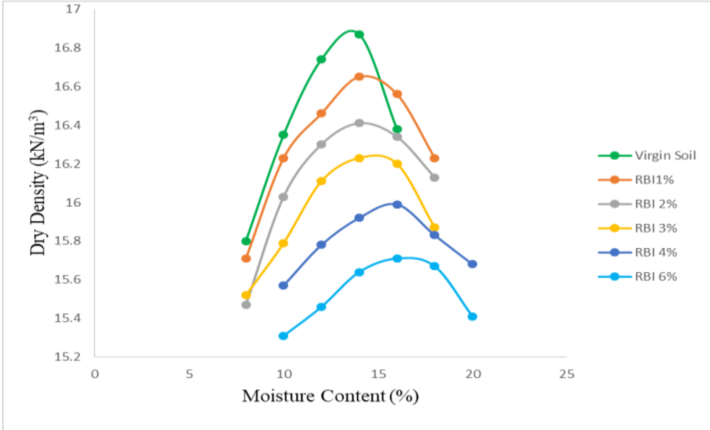

Figure 3: CBR Test

IV. RESULTS AND DISCUSSION:

4.1 Standard Proctor Test Results:

The **Standard Proctor Test** was performed to determine the **Optimum Moisture Content (OMC)** and **Maximum Dry Density (MDD)** of untreated soil, as well as soil mixed with RBI Grade 81 and fly ash. The test results showed that as the percentage of RBI Grade 81 and fly ash increased, there was a slight increase in the OMC and a corresponding decrease in MDD. The increase in OMC can be attributed to the increased surface area of the additives, which required more water to reach maximum compaction. The decrease in MDD is likely due to the lighter weight of fly ash and RBI compared to the natural soil.

The following trends were observed:

- For untreated soil, the MDD was 1.63 g/cc, and the OMC was 17%.
- With the addition of 10% fly ash, the MDD decreased to 1.59 g/cc, and OMC increased to 17.2%.
- When 5% RBI Grade 81 was added along with 10% fly ash, the MDD further reduced to 1.53 g/cc, while OMC increased to 18%.

 DOI : 10.35291/2454-9150.2024.0397

These results indicate that using fly ash and RBI Grade 81 reduces the density of the soil, making it lighter but requiring more moisture to achieve compaction

TABLE 2

Sr No.	Soil: fly ash: RBI	MDD(g/cc)	OMC (%)
1	100:0:0	1.63	17
2	90:10:0	1.59	17.2
3	80:20:0	1.55	17.4
4	70:30:0	1.54	18.3
5	89:10:1	1.60	17.5
6	87:10:3	1.56	17.8
7	85:10:5	1.53	18

Figure 4: MDD, OMC Values

4.2 **California Bearing Ratio (CBR) Test Results***:*

The **CBR test** was conducted to evaluate the strength of the treated and untreated soil samples under different conditions. The CBR value of the untreated expansive soil was found to be 1.76%, which is relatively low and typical of weak soils.

Upon mixing soil with varying proportions of fly ash and RBI Grade 81, significant improvements were observed:

- The CBR value increased to **2.71%** when 10% fly ash was added.
- The maximum improvement was seen when 5% RBI Grade 81 and 10% fly ash were added, resulting in a CBR value of **9.75%**.

The increase in CBR values can be attributed to the stabilizing effect of the RBI Grade 81 and fly ash, which improves the binding and overall strength of the soil. The addition of these materials helps form a stronger soil matrix, enhancing load-bearing capacity and making it suitable for use in subgrade layers of roads and pavements.

TABLE 3

Sr No.	Soil : flyash: RBI	CBR value
1	100:0:0	1.76
2	90:10:0	2.71
3	80:20:0	3.90
4	70:30:0	3.84
5	89:10:1	3.95
6	87:10:3	7.11
7	85:10:5	9.75

4.3 **Discussion***:*

The test results demonstrate that RBI Grade 81 and fly ash can effectively enhance the engineering properties of expansive soils. The significant improvement in CBR values suggests that these materials are capable of improving soil strength to meet construction requirements. The optimum mix proportion, based on the tests conducted, is found to be **85% soil, 10% fly ash, and 5% RBI Grade 81**, which provides the best balance between compaction and strength. These results are promising for projects involving weak subgrade soils, especially in road construction where high load-bearing capacity is crucial.

Additionally, the observed reduction in soil density (MDD) due to the inclusion of lighter additives like fly ash may lead to cost savings in transportation and handling. However, the increase in OMC suggests that more water is required for compaction, which should be factored into the project planning for regions with limited water resources.

V. CONCLUSION:

The research shows that **RBI Grade 81** and **fly ash** can significantly improve the properties of expansive soil, making it more suitable for construction purposes. The experimental results demonstrate that combining **85% soil, 10% fly ash, and 5% RBI Grade 81** yields the best outcomes in terms of strength and stability.

The **California Bearing Ratio (CBR)** increased from **1.76%** for untreated soil to **9.75%** with the optimal mixture, indicating a substantial improvement in the soil's load-bearing capacity. The decrease in **Maximum Dry Density (MDD)** and the increase in **Optimum Moisture Content (OMC)** suggest that the treated soil requires more moisture but becomes lighter, which can be beneficial for handling and compaction.

The use of **RBI Grade 81** and **fly ash** offers a sustainable and cost-effective solution for stabilizing expansive soils, especially in road construction and subgrade improvement projects. By using industrial by-products like fly ash, this method also contributes to reducing environmental waste.

Further studies could explore the long-term performance of stabilized soils in different environmental conditions, as well as the economic benefits of using this stabilization technique on a larger scale.

APPENDIX

Soil Properties *(Untreated Soil)*

Sr. No.	Property	Value
1	Specific Gravity	2.3
2	Liquid Limit (%)	58.78
3	Plastic Limit (%)	31.3
4	Plasticity Index (%)	27.48

 DOI : 10.35291/2454-9150.2024.0397

5	Soil Classification (IS)	CH (Clay of High Plasticity)
6	Optimum Moisture Content (%)	17
7	Maximum Dry Density (g/cc)	1.63
8	CBR Value (Soaked)	1.76%

Mix Proportions Used for Testing

Sr. No.	Soil (%)	Fly Ash (%)	RBI Grade 81 (%)
1	100	0	0
2	90	10	0
3	85	10	5

Experimental Test Results

1. **Proctor Test Results**:

- **Untreated Soil:**

❖ Optimum Moisture Content (OMC): 17%

❖ Maximum Dry Density (MDD): 1.63 g/cc

- **Treated Soil** (85% Soil, 10% Fly Ash, 5% RBI Grade 81):

❖ OMC: 18%

❖ MDD: 1.53 g/cc

2. California Bearing Ratio (CBR) Test Results:

- **Untreated Soil:** 1.76%
- **Treated Soil** (85% Soil, 10% Fly Ash, 5% RBI Grade 81): 9.75%

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