

# Effect of Bio-Char on geotechnical properties of Red moorum Soil

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**Abstract** – Red moorum soil has been used, which is obtained from weathering of metamorphic rock. Soil stabilization has been extensively used in the construction of roads, airfields, earth dams and embankments, in erosion control, etc. The soil sample was collected from Aravind eye Hospital site Alipiri, Tirupati and treated with various percentages of bio-char, ranging from 0% to 10% by weight. The treated soil samples were then tested for observing the index properties of soil. Based on the test results it can be concluded that, with the addition of Bio-Char significantly improved the Index properties of red moorum soil.

**Key Words:** Red moorum soil, Liquid Limit, Plastic Limit and Specific Gravity, Bio-Char

## 1. INTRODUCTION

Red moorum soil is a common soil type found in tropical regions around the world, including India. It is formed by the weathering of rocks in hot and humid environments, which results in a reddish-brown color and a high iron oxide content. Laterite soil is found throughout India, with significant deposits in the states of Kerala, Karnataka, Maharashtra, Odisha, and Andhra Pradesh. Despite its widespread occurrence, laterite soil presents several challenges for construction projects due to its low bearing capacity and compressibility. In this study, we focused on improving the geotechnical properties of laterite soil through the addition of bio-char. Specifically, we investigated the effect of bio-char stabilization with different percentages (0%, 2%, 4%, 6%, 8%, and 10%) on the liquid limit, plastic limit, and specific gravity.

## 2. MATERIALS USED

### 2.1 Soil Sample

The soil sample was collected from Aravind eye Hospital site Alipiri, Tirupati, Andhra Pradesh.



Fig -1: Red Soil (Laterite soil)

### 2.2 Bio-Char

Biochar is a type of charcoal made through the pyrolysis process of heating organic materials (such as wood, agricultural waste, or other biomass) in the absence of oxygen.



Fig -2: BIO-CHAR

## 3. EXPERIMENTAL INVESTIGATION

The Properties of soil sample were tabulated below

Soil properties	Value
Specific gravity	2.57
Liquid limit (%)	28
Plastic limit (%)	16.25
Plasticity Index (%)	11.75
Max dry density (g/cm <sup>3</sup> )	2.08
Optimum moisture content (%)	11

Table -1: Physical properties of red soil

### 3.1 Liquid Limit:

The liquid limit of soil is the moisture content at which a soil changes from a plastic state to a liquid state when a standard amount of force is applied to it. The test for liquid limit involves determining the number of blows required for a groove to close a specified distance when a standard device called a liquid limit apparatus is used.



Fig -3: LIQUID LIMIT APPARATUS

### 3.2 PLASTIC LIMIT:

Plastic limit is defined as the water moisture content at which a thread of soil with 3.2mm diameter begins to crumble.



Fig -4: PLASTIC LIMIT

### 3.3 SPECIFIC GRAVITY:

Specific gravity is a measure of the density of a substance compared to the density of water at a specified temperature. In geotechnical engineering, the specific gravity of soil is an important parameter as it can provide information about the soil's composition, mineralogy, and strength.



Fig -5: SPECIFIC GRAVITY

## 4. ANALYSIS OF TEST RESULTS

### 4.1 Bio-Char Amended Liquid Limit

The liquid limit of the soil decreases as the percentage of bio-char increases from 0% to 2%, and then it starts to increase with further increases in the percentage of bio-char. At 6% bio-char, the liquid limit is similar to that of the soil without bio-char, but at 8% and 10% bio-char, the liquid limit is higher than that of the soil without bio-char.

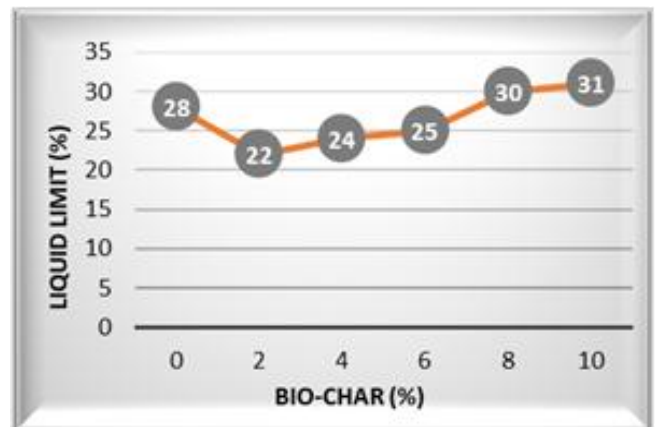


Chart -1: Variation of Liquid limit with Bio-Char Contents

### 4.2 Bio-Char Amended Plastic Limit

The plastic limit of the soil increases steadily as the percentage of bio-char increases from 0% to 8%. At 8% bio-char, the plastic limit is the highest among all the percentages tested. However, at 10% bio-char, the plastic limit decreases slightly compared to the value at 8% bio-char, but it's still higher than the plastic limit of the soil without bio-char.

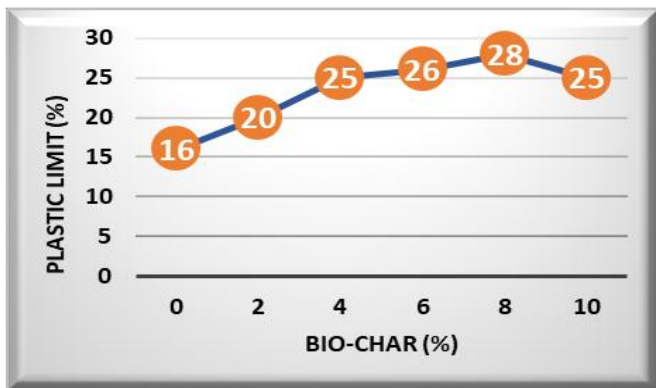


Chart -2: Variation of Plastic limit with Bio-Char Contents

#### 4.2 Bio-Char Amended Specific Gravity:

The fig shows that the addition of bio-char to the soil has a noticeable effect on its specific gravity. Specifically, as the percentage of bio-char increases, the specific gravity of the soil tends to decrease.

At 0% bio-char, the specific gravity of the soil is 2.57. At 2% bio-char, the specific gravity increases significantly to 2.9, but then it starts to decrease as the percentage of bio-char increases further. The lowest specific gravity value is observed at 10% bio-char, with a value of 2.63.

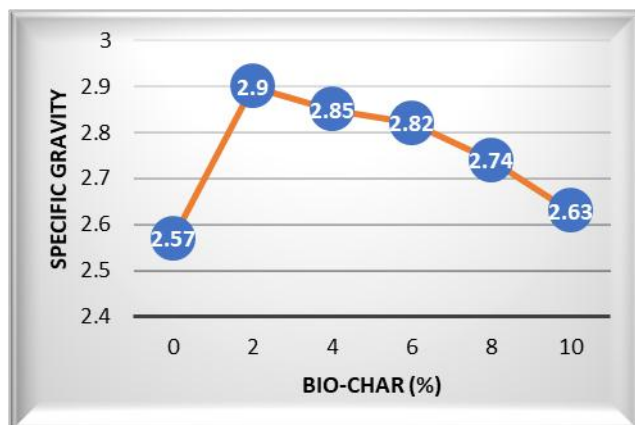


Chart -6: Variation of Specific Gravity with Bio-Char Contents

Biochar content (%)	Liquid limit (%)	Plastic limit (%)	PI	Specific Gravity (G)
0	28	16	12	2.57
2	22	20	2	2.9
4	24	25	1	2.85
6	25	26	1	2.82
8	30	28	2	2.74
10	31	25	6	2.63

Table -2: Comparison of Bio-Char with Liquid limit, Plastic Limit and Specific Gravity.

#### 5. CONCLUSIONS:

- 1 The addition of bio-char to laterite soil has a significant effect on its geo-technical properties, including its liquid limit, plastic limit, and specific gravity
- 2 The optimal percentage of bio-char to be added to the soil varies depending on the property being targeted.
- 3 For the liquid limit, adding 2% bio-char reduces the value, but beyond that percentage, the liquid limit increases.
- 4 For the plastic limit, adding bio-char steadily increases the value up to 8% bio-char, but further increases beyond that result in a slight decrease.
- 5 For the specific gravity, adding bio-char results in a decrease in the value.
- 6 The use of bio-char in soil improvement has potential but should be considered in light of its effects on soil mechanical properties and ability to support structures or resist deformation.

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