# Soil Stabilization Using Bamboo Fibre

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***Abstract*: The process of soil stabilization entails strengthening the physical characteristics of the soil by blending or combining with chemicals in order to improve its strength, durability, etc. The various methods for stabilizing soil include chemical stabilization, bitumen stabilization, bitumen stabilization with cement, stabilising soil with lime, stabilizing soil with cement, and a novel emerging method using geotextiles and geosynthetic fibres. For soil stabilisation in this study, bamboo fibers are used as a geosynthetic material. The CBR values will rise when bamboo fibres are added to the soil, and the pavement layer thickness will also decrease. A geosynthetic material that is readily available, environmentally benign, and economical is bamboo fibres. When using the soil stabilisation approach during construction, the overall cost is lower than when using the conventional method. It was discovered what the soil's liquid limit, MDD, OMC, shear strength, and CBR value were. We deduced from the limited laboratory research that 0.75 percent bamboo fibre can significantly enhance the characteristics of black cotton soil. The project's advantages include the ability to make high-quality concrete and the cost of employing bamboo fibre for soil stabilisation.**

***Keywords*: Soil, bamboo fibre, strength, durability, environmental friendliness.**

## 1. Introduction

A developing nation with the size and population of India needs a vast infrastructure, including a network of highways and structures. Land is used for a variety of constructions everywhere, including simple houses, skyscrapers, airports, bridges, and motorways. The majority of civil engineering constructions are positioned on different soil layers. A substance made up of clay, sand, silt, and rock fragments is referred to as soil. It is created by the progressive disintegration or breakdown of rocks as a result of natural processes. One such process is the disintegration of rocks as a result of tensions brought on by the expansion or contraction of rock owing to temperature variations. Sand, silt, and clay are being formed as a result of weathering and decomposition, which is caused by chemical reactions between minerals in the rock formation and water, oxygen, and carbon dioxide over time. Different soil formations, including those in river deltas, sand dunes, and glacial deposits, are the result of the movement of soil components by wind, water, and ice. In all climatic zones, factors such as temperature, precipitation, and drainage are crucial for soil formation. Different soils will develop from the same original rock formation under various drainage regimes. alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, sand dunes, and boulder deposits are the six categories into which soils in India are divided. In general, lateritic soil deposits cover 1 lakh square kilometers, black cotton soil 3 lakh square kilometers, and sand dunes 5 lakh square kilometers of land. When building on land with soft soil, emphasis is drawn to using ground-improvement procedures such soil stabilization.

By blending or combining it with additives, the physical characteristics of the soil are improved during the process of soil stabilization, which also increases its strength, durability, and other attributes. There are many different ways to stabilize soil, including using cement, lime, bitumen, chemicals, geotextiles, and synthetic fibres. Cement, lime, bitumen, and chemical stabilisation are the most common types of stabilisation methods.

Geosynthetics are manufactured goods from several kinds of polymers that can be woven or non-woven. These have made it feasible to build civil engineering structures economically and are utilized to improve the properties of soil. For soil stabilisation in this study, bamboo fibres are used as a geosynthetic material. The CBR values and pavement layer thickness may both increase with the addition of bamboo fibres to the soil. Additionally, it might lessen how stressful subgrade is. Bamboo fibres are a type of geosynthetic material that are readily available, cost-effective, and environmentally benign. When compared to the conventional method of building, the overall cost may be decreased with the use of soil stabilisation techniques.

## 2. Need of Soil Stabilization

We need to stabilize the soil to increase the load carrying capacity because soil qualities vary greatly and the building of structures heavily depends on the bearing capacity of the soil. When working with soils, it's also crucial to keep the gradation of the soil in mind. The soils may be equally graded, which sounds stable but has more voids, or well-graded, which is preferable since it has less voids.

### *A. Advantages*

*Increased soil strength:* The addition of bamboo fibres to soil can increase its strength and stability, making it more resistant to erosion and other forms of damage.

*Cost-effective:* Bamboo fibres are readily available and

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relatively inexpensive, making them a cost-effective option for soil stabilization

*Environmentally friendly:* Bamboo is a sustainable resource that grows quickly and requires fewer resources to cultivate than many other plants. Using bamboo fibres for soil stabilization is therefore an environmentally friendly option.

*Biodegradable:* Unlike synthetic materials, bamboo fibres are biodegradable, meaning that they will break down over time and do not contribute to environmental pollution.

*Reduced maintenance:* Soil stabilized with bamboo fibres is less prone to erosion and other forms of damage, reducing the need for maintenance and repairs over time.

### B. Objective

*Increased load-bearing capacity:* Stabilizing soil using bamboo fibre can increase its load-bearing capacity, making it more resistant to compression and deformation under heavy loads.

*Improved stability:* The addition of bamboo fibre can improve the stability of soil, reducing the risk of erosion, landslides, and other types of instability.

*Reduced settlement:* Stabilizing soil using bamboo fibre can also help to reduce settlement over time. This can be particularly important in applications such as building foundations, where settling can lead to structural damage.

*Increased durability:* The addition of bamboo fibre can also increase the durability of soil, making it more resistant to weathering and degradation over time. This can be important in applications such as landscaping, where the soil needs to be able to support vegetation over a long period of time.

## 3. Methodology

*Determine the soil type:* The first step is to determine the type of soil you are working with. The type of soil will dictate the amount of bamboo fiber needed and the technique used to stabilize the soil.

*Collect and prepare the bamboo fibers:* The next step is to collect the bamboo fibers and prepare them for use. Bamboo fibers can be obtained by cutting bamboo stalks into small pieces and then processing them into fibers. The fibers should be cleaned and dried before use.

*Mix the soil and bamboo fibers:* The next step is to mix the soil and bamboo fibers thoroughly. The mixing process can be done manually or using a mixing machine. The amount of bamboo fibers used should be based on the type of soil and the degree of stabilization required.

*Compact the mixture:* Once the mixture is thoroughly mixed, it should be compacted using a compactor machine. The compaction process helps to increase the density of the mixture and improve its stability.

### A. CBR Test

Make a 4.5 kg sample of dry dirt that passes through a 4.75 mm IS sieve. Mix well after adding the ideal quantity of water. Apply grease to the inner surface of the CBR mould, set the spacer disc at the bottom of the mould with a filter paper covering it, and then add the soil sample to the mould in five layers, tamping each layer down with a 2.6 kg rammer and a 450 mm free fall to achieve the necessary density. Maintain the 4.5 kg surcharge weight, which consists of two plates weighing 2.5 kg each. Remove the component, then use a motorised loading machine to test it for CBR.

The specimen-containing mould is positioned over the base plate, and the same number of surcharge weights are distributed evenly across the specimen to enable the penetration test. Under the loading machine's penetration plunger is where the mould with the base plate is positioned. Applying a seating weight of 3.78 kg causes the penetration plunger, which is seated in the middle of the specimen, to come into contact with the soil sample's top surface. The dial gauge for calculating the plunger's penetration values is set to zero and is installed in its proper location.

Additionally, the dial gauge of the load cell reading or proving ring is set to zero and does not take the seating weight into account.

A uniform rate of 1.24 millimetres per minute is used to apply the weight through the motorised loading machine's penetration plunger. The load measurements are captured at penetration readings of 0, 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7.5, 10, and 12.5 mm. The highest load value and the related penetration value are recorded in the case that the load measurements start to decrease before 12.5 mm of penetration. The load is released and the mould is taken out of the loading machine after the final measurement. If the load values are provided by the proving ring assembly, the calibration factor of the proving ring is noted in order to translate the load dial values into weight in kilograms.

Fig. 1. Removing bamboo fibre


Fig. 2. Murum soil


Fig. 3. Seiving (4.75mm seive)

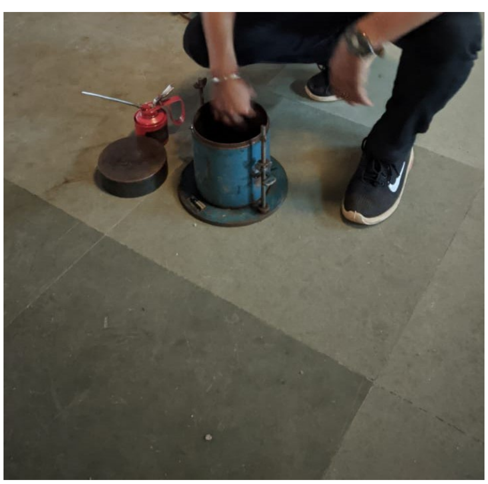
Fig. 4. Oiling of mould


Fig. 5. After seive soil (4.75mm)

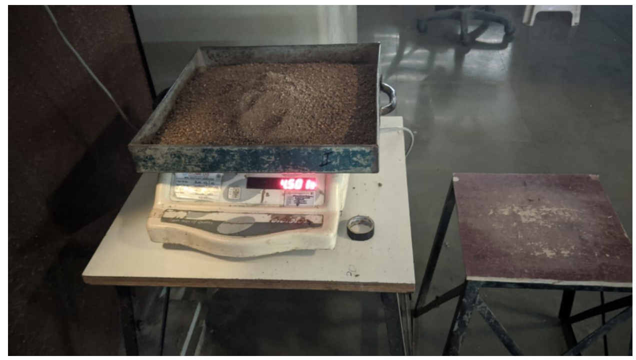
Fig. 6. Weight of dry soil (4.5 kg)


Fig. 7. CBR apparatus


Fig. 8. Dry soil (4.5 kg weight)

Fig. 9. Dry soil with bamboo fibre (4.5 kg)

Fig. 10. Mixing of dry soil (160ml water)

Fig. 11. Mixing of dry soil with bamboo fibre (160ml water)

Fig. 12. Compacting of soil in 3 layers


Fig. 13. Weight of compacted soil (without Fibre)

Fig. 14. Weight of compacted soil (with fibre)

Fig. 15. Testing of both compacted soil

Fig. 15. Result after testing

## 4. Results and Discussion

Table 1
CBR test on Murum soil (Without fibre)

| Penetration in mm (Without fibre) | Poving Ring Division | Load in kg (Without fibre) |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 1 | 3.78 |
| 1 | 4.6 | 17.388 |
| 1.5 | 8.4 | 31.752 |
| 2.0 | 11.2 | 42.336 |
| 2.5 | 13.2 | 49.896 |
| 3 | 14.4 | 54.432 |
| 4 | 16.2 | 61.236 |
| 5 | 17.4 | 65.772 |
| 6 | 18.6 | 70.308 |
| 7.5 | 20.2 | 76.356 |
| 10 | 23 | 86.94 |
| 12.5 | 25.2 | 95.256 |

The calculated load at 2.5 mm of penetration is 49.896 kg CBR of the specimen, or (49.896/1370) *100=3.642%.

The load calculated from the curve for a specimen is 65.772 kg CBR of (65.772/2055) *100=3.201%.

Table 2
CBR test on Murum soil (With fibre)

| Penetration in mm (With fibre) | Poving Ring Division | Load in kg (With fibre) |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 3 | 11.34 |
| 1 | 6.6 | 24.948 |
| 1.5 | 9.4 | 35.532 |
| 2.0 | 11.6 | 43.848 |
| 2.5 | 13.2 | 49.896 |
| 3 | 14.4 | 54.432 |
| 4 | 16.6 | 62.748 |
| 5 | 18.6 | 70.308 |
| 6 | 20.6 | 77.868 |
| 7.5 | 23.6 | 89.208 |
| 10 | 28.6 | 108.108 |
| 12.5 | 33.4 | 126.252 |

The calculated load at 2.5 mm of penetration is 49.896 kg CBR of the specimen, or (49.896/1370) *100=3.642%.

The load calculated from the curve for a specimen is 34 kg CBR of (70.308/2055) *100=3.421%.

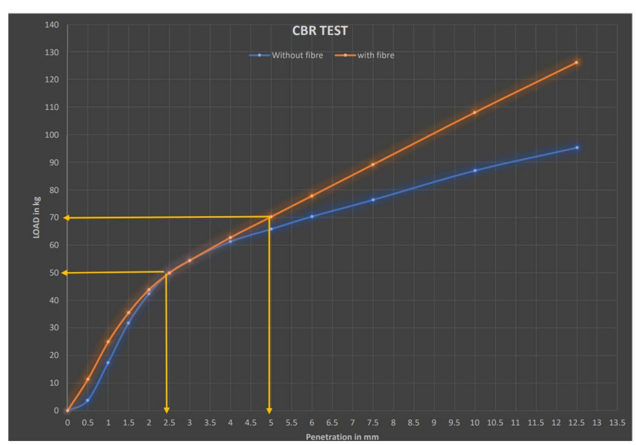


Fig. 16. CBR Curve for Murum soil

The CBR value was found to 3.642%, 3.201%, 3.642%, 3.421% respectively, by adding various amounts of bamboo fibres to the earth (0.25%).

Bamboo fibre additions of 0.25, 0.50, 0.75, and 1.0% by weight of soil are proven to increase soil's CBR value.

## 5. Conclusion

1. When 1% of bamboo fibres (by weight of soil) are added, the soil's shear strength is at its highest. 1% of fibres (by weight of soil) can thus be thought of as the ideal fibre in order to get increased shear resistance content.
2. Stabilizing soil using bamboo fiber can be an effective and environmentally friendly approach to improve soil strength and stability.
3. Bamboo fibers are a sustainable and readily available material that can enhance the mechanical properties of soil, including its compressive strength, tensile strength, and shear strength.
4. The use of bamboo fibers in soil stabilization can also help to reduce soil erosion, settlement, and increase its load-bearing capacity.
5. After stabilizing the soil with an appropriate amount of bamboo fibers, the California bearing ratio (CBR) of the soil improved from 3.201% to3.642%
6. The California bearing ratio (CBR) of the soil alone is calculated and the CBR value significantly increases when fibres are added.

Overall, stabilizing soil using bamboo fiber has numerous benefits, such as being an eco-friendly alternative to synthetic materials, improving soil strength, reducing soil erosion, and enhancing soil stability. However, further research is needed to fully understand the long-term effects and effectiveness of this technique in different soil conditions and environments. Nonetheless, it has great potential to be used in various applications, including road construction, slope stabilization, and building construction.

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