

# Utilization of Coir Pith for the Stabilization of Black Cotton Soil



Ch Vineel, T V ViswaTeja, M Usha Rani, B Vineeth, B Vamsi Krishna

**Abstract:** *Expansive soil deposits mostly appear in arid and semi-arid areas of the world and they pose severe difficulties to engineering constructions as they possess higher tendency to heave in the course of moist season and shrink at summer season. Construction in such highly expansive strata can be done by adopting ground modification techniques like soil stabilization, Vertical drains, inducing reinforcement in to soil etc., On the other hand with rapid industrial growth more quantity of industrial waste will be generated which will trigger several environmental issues when it is dumped in to environment. Utilization of industrial waste in construction industry without compromising in strength criteria is the best possible option for the engineers as the waste is used as construction material there will be no need for dumping yards, biodiversities can be protected, strength properties of the soil can be enhanced and hydraulic properties can also be modified by treating soil with industrial wastes. As the river sand can be partially replaced by some of the industrial wastes requirement for natural sand can be reduced which will not only economise the construction cost but also preserves the natural resources. The present study was carried out to assess the behaviour of coir pith treated black cotton soils. Due to increase in the natural fibres in many industries the waste produced from the coir industry is increasing, if proper care is not taken these waste may create severe effects on environment .To avoid disposal of this waste directly into environment it is better to use the waste in construction industry is a better option. But before adopting such practices proper studies are to be done to check whether these materials are suitable for treating the soils are not .In the present study by adding various proportions of coir pith Swell, strength characteristics of soil where compared for obtaining the optimum Replacement percentage.*

**Keywords:** *Black Cotton Soil, Coir pith, Soil Stabilization, Strength characteristics.*

## I. INTRODUCTION

Majority area in India is covered by Black cotton soil. Mostly at Central, western and southern states of India we

can found deposits of black cotton soils. These soils undergo volumetric changes when there is a change in moisture content in it which poses severe problems to structures constructed over them. Therefore, stabilization of such soils is needed to be done. Many studies were conducted to modify the locally available problematic soil by using natural, artificial/synthetic fibers, agricultural and industrial wastes to stabilize the soils. The utilization of wastes for treating the soils not only improves the strength but also it reduces the environmental effects caused due to open dumping of these wastes. Among the world India produces largest quantity of coir. In the coir producing industry the fibres are extracted from the coconut husk, during this process a by product is obtained which is known as Coir pith. It is estimated that about two tons of coir pith is produced for every ton of fibre extracted. As the coir pith is lite in weight it will cause environmental nuisance if it is disposed on open site. To avoid such problems instead of dumping, it is used for treating the black cotton soils. It was found that coir pith has great capacity of moisture absorption so when it is treated with soil it will absorb the moisture hence reduces the volume changes in the soil.

## II. REVIEW OF LITERATURE

**Narendra Goud, G., et. al., (2018)** has investigated the properties of black cotton soil treated with various proportions of coir pith and lime. With increment in coir pith content the Maximum dry density got decreased and optimum moisture content increased. Addition of lime made the black cotton soil suitable for sub grade by reducing its swell index value. Combined effect of lime and coir pith causes a significant increase in the CBR value.

**Arthi, P.D., et. al., (2017)** has studied the enhancement in the properties of expansive soil with addition of Coir Pith in various proportions. The atterberg limits, OMC, MDD and UCS values are obtained with various proportions of coir pith replacements. 2% & 3% Addition of coir pith showed reduction in plasticity index and increment in the MDD, UCS values of black cotton soil. California Bearing Ratio strength increased with increment in the coir pith percentage.

**Leemapeter et. al., (2016)** in his study he found that coir pith can be effectively used for enhancing the engineering properties of subgrade black cotton soil. He observed an increment of 192% and 335% in the CBR value with an addition of 2% coir pith and 0.6% of short coir fiber

**Stuti Maruya et.al., (2015)** has investigated the index and engineering properties of black cotton soil treated with coir pith. Various proportions of coir pith and lime are mixed with black cotton soils to reduce the swelling and shrinkage behavior of soil. CBR and UCS tests were conducted under soaked and unsoaked

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conditions. From the study he observed that both CBR and UCS strength values increased when soil is mixed with 1% of coir pith.

**Shruthi Johnson. et., al., (2016)** has investigated that with an addition of 12% of there is a decrement in the MDD value where as they found an increment of OMC values at the same percentage of coir pith. The density of the coir pith soil mixture reduces with an increment in the coir pith percentage due to coir pith low dense nature. As coir pith absorbs more quantity of water its OMC will increase with an increment in coir pith percentage in soil but it will exhibit a good binding property with clay. Reduction in swell pressure is observed with an increment in the percentage of coir pith in soil

**Gayatri. S et., al.,** has investigated that when the expansive soil is treated with coir pith the swelling characteristics decreased from 22.22 % to 8.33 % at 4 % of coir pith and 4.85 % at 10 % of coir pith. Addition of 4% of coir pith gives the highest unconfined compressive strength of 0.206 N/mm<sup>2</sup>. Addition of 6% of coir pith gives the highest MDD of 1.43 gm/cm<sup>3</sup> and OMC of 17.5%.

**Raziya banu et.al., (2015)** has investigated the variations of the engineering properties of black cotton soil with various proportions of coir pith. They found decrement in the liquid limit with an increase in coir pith percentage. They also found that there is an increment in the MDD and UCS values upto 0.2% of coir pith. After 0.2% coir pith further addition of coir pith reduced the MDD. As UCS characteristics are considered the strength increased with the increase of curing days upto 0.2% coir pith when compared to untreated BC soil.

**III. EXPERIMENTAL WORK**

The properties of black cotton soil and coir pith are determined by performing various experiments in geotechnical engineering lab. The properties determined are presented in Table I.

Table I Properties of black cotton soil and Coir Pith

Engineering properties	Soil	Coir Pith
Specific Gravity (G)	2.64	0.67
Grain Size distribution		
a) Gravel	0	-
b) Sand	93.49%	-
c) Percentage of Fines	6.51%	-
d) C <sub>u</sub>	5.0	4.25
e) C <sub>c</sub>	1.2	0.94
Plasticity Characteristics		
a) Liquid limit	51.90%	NP
b) Plastic limit	26.16%	NP
c) Shrinkage Limit	12.34%	NP
IS classification	CH	SP
Compaction Characteristics		
OMC (%)	24.2	25.73
MDD (g/cm <sup>3</sup> )	1.485	0.251
CBR (%)	3.89%	-

U.C.S (kN/m <sup>2</sup> )	60.81	-
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**Comparison of Strength Properties of Black Cotton soil treated with various proportions of Coir pith**

Coir pith of 1.0%, 1.5% and 2% are mixed with black cotton soil and various laboratory experiments like Modified Proctor test, Swell Pressure test, Unconfined Compressive strength test, California Bearing Ratio Test are performed. The results obtained are presented in Table 2.

**Table II Comparison of Properties of Black Cotton Soil treated with various proportions of Coir pith**

Experiment	1.5 % Coir Pith	2.0 % Coir Pith	2.5 % Coir Pith
U.C.S (kN/m <sup>2</sup> )	74.02	95.34	65.96
Swell Pressure (kN/m <sup>2</sup> )	75.4	65.72	60.00
C.B.R (%)	9.34	11.67	12.45
OMC (%)	25	26.39	25.45
MDD (g/cm <sup>3</sup> )	14.40	14.08	13.76

**IV. RESULT AND DISCUSSION**

1. From the compaction test the Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) for Black Cotton Soil and Coir pPith are obtained as 14.80kN/m<sup>3</sup>,24.2%, and 2.5kN/m<sup>3</sup> ,25.73% respectively. The density of the coir pith replaced soil has decreased with an increment in coir pith. The MDD obtained for 1.5%,2.0%,2.5% coir pith replaced soil are 14.40 kN/m<sup>3</sup>, 14.10 kN/m<sup>3</sup>, 13.76kN/m<sup>3</sup>.
2. The Unconfined Compressive Strength (UCS) of virgin soil is obtained as 60.81kN/m<sup>2</sup>, with the replacement of various proportions of coir pith the UCS Values shown an increment. The percentage increment of UCS for 1.5%, 2.0%, and 2.5% coir pith replacement are 21.73%, 56.78%, 8.46%.
3. The Unconfined Compressive Strength (UCS) of virgin soil is obtained as 60.81kN/m<sup>2</sup>, with the replacement of various proportions of coir pith the UCS Values shown an increment. The percentage increment of UCS for 1.5%, 2.0%, and 2.5% coir pith replacement are 21.73%, 56.78%, 8.46%.
4. At 1.5% of coir pith the UCS Value obtained as 74.02kN/m<sup>2</sup>, with an increase of 0.5% of coir pith the strength got increased upto 28.80%, where as with an further increase of 0.5% of coir pith the UCS value decreased by 30.81%.
5. The swell pressure for the virgin soil is obtained as 83kN/m<sup>2</sup>. With replacement of various proportions of coir pith the swell pressure has shown decrement of 75.4kN/m<sup>2</sup>,65.72 kN/m<sup>2</sup>, 59.72 kN/m<sup>2</sup>. with addition of 0.5% of coir pith the percentage decrement in Swell Pressure is obtained as 12.83% whereas with a further increment of 0.5% it showed an decrement of 10.04%.
6. The CBR value obtained for virgin soil is 3.89%. with replacement of various proportions of coir pith the CBR value also increased. By adding 1.5% of coir pith the Increment in CBR percentage is obtained as



1.45% whereas with a further increment of 0.5% it showed an increment of 2.07%.

## V. CONCLUSION

The Present work reveals that with the addition of Coir pith the swell and shrinkage behaviour of the black cotton soil can be effectively controlled. The MDD values of the coir pith stabilized soil shown minor decrement which shows there is no much effect on strength of stabilized soil. The decrease in the M.D.D Values are due to reduction in the weight of soil after replacing it with certain proportion of coir pith is due to lesser density of coir pith compared to black cotton soil. The UCC values got increased at 2% coir pith replacement after that it showed decrement which suggests that with addition of coir pith the Compressive Strength of soil gets modified up to a certain value. In the present study it was observed that the CBR Values shown increment with increase in percentage replacement of coir pith up to 1.5%. From the study it was observed that the coir pith can be utilized for stabilizing the black cotton soils effectively without compromising on strength parameters.

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