

# “IMPROVMENT OF SWELLING PROPERTIES OF EXPANSIVE SOIL BLENDING WITH SAND AND CEMENT”

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## ABSTARCT

This paper presents the study of black cotton soil and its recurrent volume changes with the variation of moisture content , this soil has a unique shrink-swell behavior which changes along variation in soil water content reduces the strength that can damage a structure. To control the swelling potential of soil is one of the important criteria to the civil engineers. Several attempts are being made all over the world to improve the swell-shrink phenomenon of expansive soil. Generally black cotton soil is available all over the world in abundance and also covers nearly 20% of geographical area in India, so in this paper improvement in expansive soil is studied by varying percentage of sand and constant percent of cement. Various tests have been performed such as sieve analysis, standard proctor test, Atterbergs limits, free swell index in the laboratory on both natural and treated soil. The result of tests indicate that engineering properties of soil is improved effectively and huge decrement in swelling behavior of expansive soil is observed.

**KEYWORDS:** Expansive soil, Moisture content, Swelling, Sand and Cement.

## INTRODUCTION

Black cotton soil considered as expansive soil contains the inorganic clay of medium to high compressibility. It contains high shrink-swell properties due to the presence of montmorillonite mineral. It is observed that black cotton soil is very much sensitive in respect of environment. Black cotton soil also shrinks when it comes to dry out, consequently fissures develop in the soil that can try to penetrate water to the deeper layers in the presence of moisture. This result gradually rises volume and eventually damages the structural projects.

Expansive soil occupies about 20% of geographical area in India, more specified, one fifth of land area of the country. They are basically covered the various zone all over the world like mostly in Africa, Tanzania, Sudan, Saudi Arabia, South Africa, The United States, China, Ethiopia, India, Spain, Jordon, Turkey, Iran, Mexico, etc .

In India, these soils can be easily found in states of M.P., A.P., Maharashtra, Gujrat, Karnataka and Tamilnadu. The engineering properties of soil can be improved by stabilizing the soil with various suitable admixtures and predominant techniques that enhance the strength of soil and make it durable for a long time. The technique which holds In this work is mixing of ordinary Portland cement and river sand with pulverized black cotton soil to attain required

densities and optimum moisture content and to reduce the swelling of soil . This premix of soil ,cement and sand is said to be cement sand soil . Cement is added 2% constantly brought appreciable changes in the index properties of black cotton soil similarly, varying proportion of inert material like sand improves the characteristics of soil .In our country expensive soil has liquid limit value ranging from 45-100% , plasticity index from 20-65% and shrinkage limit 9-14%.The result of Experimental work proves that swell increases along plasticity index, the swelling potential rely on the clay minerals , Cation exchange capacity, degree of saturation densities and water content.

#### LITERATURE REVIEW :

**SAND : An Additive for Stabilization of Swelling Clay Soils by Bahia Louafi and Ramdane Bahar., june, 2012**

This paper gives detail information about the reduction of all parameters of consistency after addition of sand. The results also evolved the importance of sand as a stabilizer of expansive soils. It is found that the placement of sand layers into different configurations proved the effectiveness of sand layers in reducing swelling.

**Stabilization of Black Cotton Soil With Sand and Cement as a Sub grade for Pavement by Mrs. Neetu B. Ramteke et al., june, 2014**

In their study experimentally found that the addition of sand and cement mix results in the improvement of soaked CBR values while using sand as increasing order and reaches up to 40% and the constantly mix cement with the natural soil. It is also observed that the free soiling index goes on decreasing with the increase in sand amount.

**Study Of Swelling Behaviour Of Black Cotton Soil Improved With Sand Column by Aparna et al., july, 2014**

They performed experimental work in the laboratory. The results show that the size of sand column and initial moisture content in expansive soil influence the swelling properties. A large size sand

column decreases swelling as compare to smaller one. It is also seen that swelling is greatly reduce with increase in moisture content. Finally by this research it is demonstrated that if the sand column are installed in black cotton soil in saturated condition maximum volume stability can be acquired.

#### MATERIAL PROPERTIES:

The following basic materials and their properties are :**1. Black Cotton Soil**

This soil sample acquired from Tekanpur , District Gwalior in M.P. India for the determination of soil properties. Samples of soil taken were air dried and sieved to pass through IS425 micron.

**Table No. 1: Engineering Properties of Black Cotton Soil.**

Description	Value
Liquid Limit (%)	46
Plastic Limit (%)	20
Plasticity Index (%)	26
MDD (g/cc)	1.37
OMC (%)	16
Shrinkage (%)	9.46
Specific gravity, G	2.01

#### 2. Sand

A granular inert material occurring natural, composed of finely mineral partical. Sample of sand used for this work is clean and course sand. This was to be properly passed through 4.75mm sieve and oven dried for 24 hours to remove its moisture before the initiation of tests.

**Table No. 2: Grain size distribution.**

Description	Value
Course sand (%)	47.8
Medium sand (%)	34.3
Fine sand (%)	14
Specific gravity, G	2.53

### 3. Cement

Cement is a binder to establish a bond among adhesive materials, it contains major amount of lime required for pozzolanic actions to occur. Silica is also one of the important ingredient thus , cement modifies or to achieve the better quality of soil further increases strength and durability. In this work , Portland pozzolanic cement (PPC) is used that easily available in the market. The specific gravity of this cement is 3.14 g/cc.

#### METHODOLOGY:

In this research work, the specified test were conducted on untreated soil to determine its properties. Soil was admixed with sand and cement to improve it's quality. The amount of sand was taken in varying proportion such as 5%,10%,15%,20% by dry weight of soil whereas amount of cement was taken as constant percentage such as 2% by dry weight of soil .According this methodology , mix sample were formed then, all experiments were done as per IS code specification to analyze engineering properties and swelling behavior on both natural and mixed soil.

The prepared mix proportion of soil,Sand and Cement are as follows:

1. Untreated soil.
2. Soil + 5% Sand + 2% Cement.
3. Soil + 10% Sand + 2% Cement.
4. .soil + 15%Sand + 2% Cement.
5. soil + 20%Sand + 2% Cement

All tests were conducted as per IS code specifications which are given below:

Grain size analysis	IS 2720 (part 4)1985
Atterberg's limit	IS 2720 (part 5)1985
Modified proctor test	IS 2720 (part 7)1983
Linear shrinkage	IS 2720 (part 40)1992
Free swell	IS 2720 (part 20)1977

### EXPERIMENTATION

All experiments were carried out from engineering point of view to identify the reduction in free swell index and to improve the engineering properties of black cotton soil.

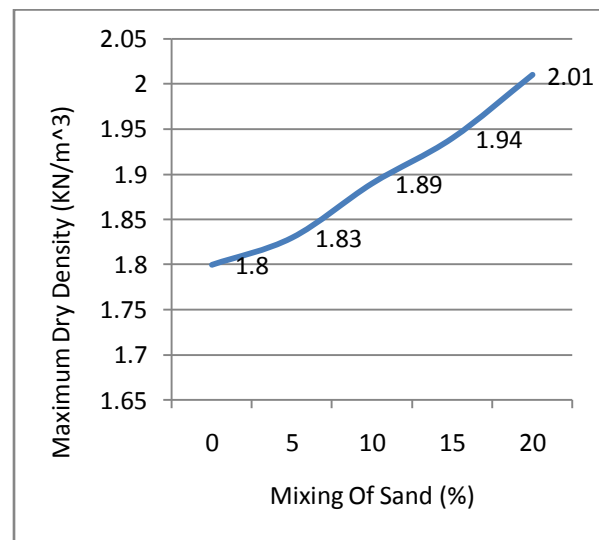
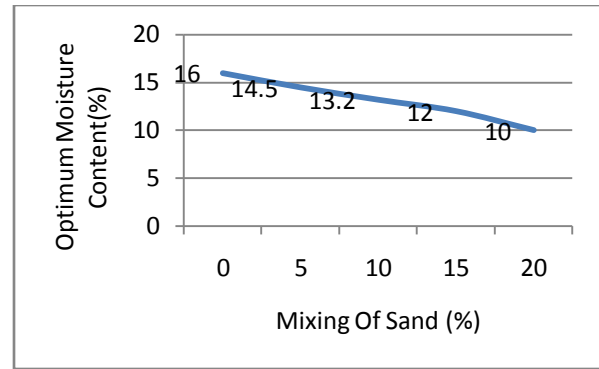
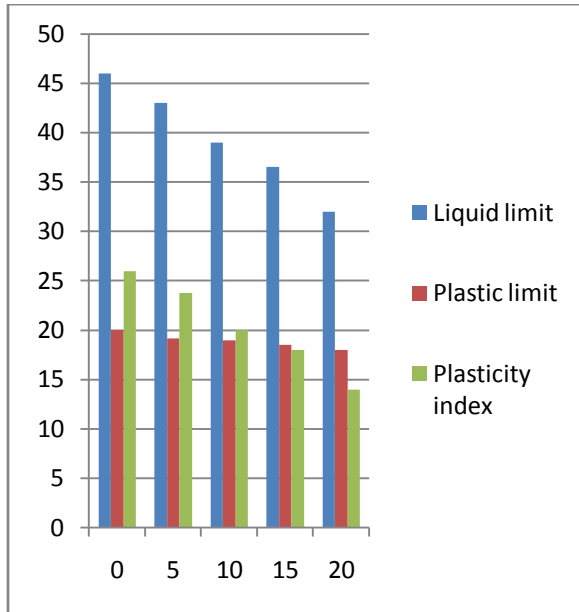
#### A. Particle Size Distribution.

According to the AASHTO classification chart, it came under the range of A-7 group and A-7-6 subgroup. By USCS (unified soil classification system) and IS classification system, soil was clearly classified as MH (silt of high compressibility)

Grain Size Distribution	
Gravel (%)	0
Sand (%)	16.2
Silt (%)	83.8
AASHTO Classification	A-7-6
USCS Classification	MH
IS Classification	MH

**B. Atterberg limit test.** These limits are a basic measure of the critical water contents of a fine grained soil, such as it's shrinkage limit, plastic limit and liquid limit. Depending upon the moisture content of soil, it may appear in four stages such as Solid, Semi-solid, plastic and liquid. The tests were being carried out with following results:

Soil Type	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Untreated Soil	46	20	26
Soil+5%Sand+2%Cement	43	19.2	23.8
Soil+10%Sand+2%Cement	39	19	20
Soil+15%Sand+2%Cement	36.5	18.5	18
Soil+20%Sand+2%Cement	32	18	14



**C. Proctor compaction test.**

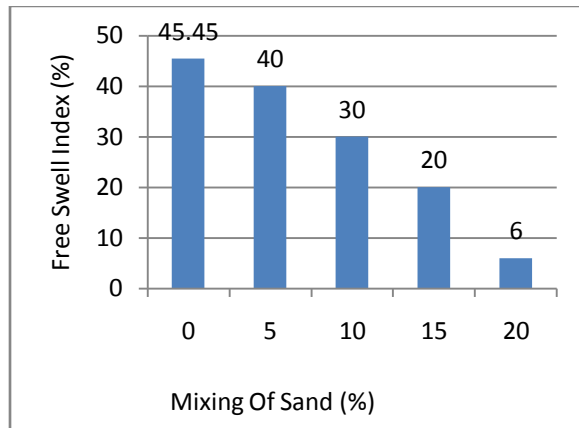
This test provides optimum moisture content and maximum dry density of soil that requires in the field. test was performed on soil sample in the laboratory. Results are given below:

Soil type	OMC (%)	MDD (kN/M <sup>3</sup> )
Untreated soil	16	1.80
Soil+5% Sand+2% Cement	14.5	1.83
Soil+10% Sand+2% Cement	13.2	1.89
Soil+15% Sand+2% Cement	12	1.94
Soil+20% Sand+2% Cement	10	2.01

**D. Free swell index.**

Differential free swell index is the increase in volume of soil , without any external constraints , only on submergence in water. The value of free swell are as follow:

Soil type	Free swell index (%)
Untreated soil	45.45
Soil+5% Sand+2% Cement	40
Soil+10% Sand+2% Cement	30
Soil+15% Sand+2% Cement	20
Soil+20% Sand+2% Cement	6



## RESULTS AND DISCUSSIONS

From the above observations, it is observed that mixing of Sand and Cement in black cotton soil reduces the swelling properties of this soil effectively, it is demonstrated that the replacement of black cotton soil by 20% sand and 2% cement decreases free swell up to a great extent. Simply stated, value reduced from 45.45% to 6%, which makes a huge difference in soil properties. The index properties of expansive soil has been improved due to the replacement of expansive soil by non expansive sand. A large proportion of sand reduced index parameter significantly, such as liquid limit reduced about 30%, plastic limit reduced about 10%, plasticity index reduced as 46%. In the case of OMC and MDD, Optimum moisture content decreased from 16% to 10%, finally reduced to 37.5% while maximum dry density increased from 1.8 to 2.01. Thus if the sand are admixed in expansive soils, maximum benefit in terms of volume stability can be achieved.

## CONCLUSION

The study concludes that the value of free swell index decreases with the increase in sand proportion and with the mix of cement content. The results of this testing program shows that addition of sand and cement mix in expansive soil controls the swelling effectively. The increasing proportion of sand in the

black cotton soil affects the swelling parameter , experimentally it is found that the mixing of sand and cement in the soil sample, results in the improvement of free swell index value from 45.45% to 6%, finally it is reduced to 86.79% with the addition of 20% sand and 2% cement respectively . By this research the atterbergs limits such as liquid limit , plastic limit also goes on decreasing with increase in sand content. The value of the liquid limit decreases up to 30% by the addition of 20% sand and 2% cement mix. In the case of compaction it came across that moisture content decreases and maximum dry density increases by increasing sand content. Thus ,the research in this area will pave the way to build up a design methodology to mitigate the troubles of black cotton soil.

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