EFFECT OF SILT FINE SAND CONTENT ON SWELLING POTTENTIAL OF CH-CLAY

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Abstract: soil stabilization is the most common ground improvement technique adopted to improve problematic soil properties. The main objective of this dissertation work will be to evaluate the swelling pressure of bentonite clay and to reduce this swelling pressure by adding silt & fine sand in different gradation and non-expansive soil(kaolinite).this paper presents and analyze the result of series of laboratory test including (sieve analysis, hydrometer, specific gravity, standard proctor test, swell pressure, free swell test) performed on untreated bentonite which is collected from bhuj (Gujarat) and black cotton soil which is collected from an urban site situated in bharuch city(dahej)

Index Terms **–black cotton soil, bentonite, kaolinite, swell pressure, shrinkage and swelling.**

I. INTRODUCTION

Soil improvement is of major concern in the construction activities due to rapid growth of urbanization and industrialization. The term soil improvement is used for the techniques which improve the index properties and other engineering characteristic of weak soils. In India expansive soil cover about 0.8x106 km2 area which is approximately one-sixth of its surface area. These soils contain montmorillonite mineral; due to this they swell and shrink excessively with change of water content. Such tendency of soils due to the presence of clay particles which swell, when they come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place. Expansive soils can be stabilised by the addition of a small percentage of lime and other admixtures. These techniques have been used for many construction purposes, notably in highway, railroad and airport construction to improve sub grades and sub-bases.

Expansive Soils

Expansive soil deposits occur in the arid and semi-arid regions of the world and are problematic to engineering structures because of their tendency to heave during wet season and shrink during dry season. It swells and shrinks excessively with change of water content. Such tendency of soil is due to the presence of fine clay particles which swell, when they come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place. Stabilization of black cotton soil has been done in this project work by using lime and stone dust as admixture.

Black Cotton Soil

Expansive soils are soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dried out. In India this Expansive soil is called ‘black cotton soil’. Colour of this soil reddish brown to black and this helps for cultivation of cotton, so is called black cotton soil. This swelling soil covers about 30% of the land area in India. They are also commonly known as expansive or Black Cotton soil. In India Black Cotton soil also known as ‘regurs’ are found in extensive regions of Deccan Trap. Black Cotton soil is one which when associated with as engineering structure and in presence of water will show a tendency to swell or shrink causing the structure to experience moments which are largely unrelated to the direct effect of loading by the structure

These clays are characterized by Having a particle size, below 2 micron.

- A large specific surface area (SSA) and
- A high Cat ion Exchange Capacity (CEC).
- High liquid limit and plasticity index.

Problems Associated With Black Cotton Soil

Black Cotton soils are problematic for engineers everywhere in the world, and more so in tropical countries like India because of wide temperature variations and because of distinct dry and wet seasons, leading to wide variations in moisture content of soils.

The following problems generally occur in black cotton soil.

(a) High compressibility

Black Cotton soils are highly plastic and compressible, when they are saturated. Footing, resting on such soils under goes consolidation settlements of high magnitude.

(b) Swelling

A structure built in a dry season, when the natural water content is low shows differential movement as result of soils during subsequent wet season. This causes structures supported by such swelling soils to lift up and crack. Restriction on heaving developed due to swelling pressures making the structure suitable.

(c) Shrinkage

A structure built at the end of the wet season when the natural water content is high, shows settlement and shrinkage cracks during subsequent dry season.

II. MATERIALS USED

The soil used for this investigation is obtained from dahej from bharuch city, Gujarat (stat). The dried and pulverized material passing through I.S.4.75 mm sieve is taken for the study. The properties of the soil are given in Table 2.1. The soil is classified as "CH" as per I.S. Classification (IS 1498:1970) indicating that it is highly compressible clay. It is highly expansive in nature as the Differential Free Swell Index (DFSI) is about 50%.

Sr no.	property	Bentonite value	Black cotton soil value
1.	Atterberg Limits (a).Liquid Limit (%) (b).Plastic Limit (%) (c).Plasticity Index (%)	135 42.55 7.11	59 31.91 10.29
2.	Plasticity index	92.4	27.09
3.	Differential Free Swell Index (%)	140	50
4.	Compaction characteristics (a).Maximum Dry Unit Weight (kN/m3) (b).Optimum Moisture Content (%)	1.301 35.17	1.581 23.18
5.	Swell pressure	3.06	1.025

III. EXPERIMENTAL PROGRAMME

SAMPLE PROCUREMENT:

Bentonite, kaolinite, fine sand was procured from the locally available sand suppliers.Grade of material is Ist class. They are fit to be used for various construction purposes.

PRELIMINARY ANALYSIS:

Dry sieve analysis of the sample was performed for the gradation. Total six sample were prepared, EXPANSIVE SOIL + (FINE SAND, SILT, SILT+FINE SAND) &EXPANSIVE SOIL+ KAOLINITE + (FINE SAND, SILT, SILT+FINE SAND).A wet analysis was carried out soil sample to obtain fines which passes through 75 microns. Material passing through 75 microns was collected in a container & allowed to settle. Then the passing material was dried in the oven pulverized. The pulverized material was aga in sieved through 75 microns' sieve. Then a hydrometer analysis was carried out to know amount of clay particles.

Then hydrometer analysis, atterberg limit were also determined all the six set of sample for classified plasticity behavior of soil. & free swell was determining for find out swelling behavior of samples.

LABORATORY TEST:

From the six remolded sand samples, the experimental study was carried out on the samples having silt & fine sand mixed with samples in the range of 0 to 15%. A series of standard proctor test, swell pressure will be performed for find out the maximum dry density & optimum moisture content, swell pressure Standard proctor was carried out for (bentonite & black cotton soil) + (5,10,15) % (silt, fine sand, silt+ fine sand) &(bentonite & black cotton soil) + 10% kaolinite + (5,10,15) % (silt, fine sand, silt+ fine sand). Total 21 standard proctor. Swell pressure was done at MDD. Total 42 swell pressure will be performed.

ANALYSIS OF RESULTS:
The results of various standard proctor test & swell pressure different sand grade proportions along with fines obtained will be analyzed.

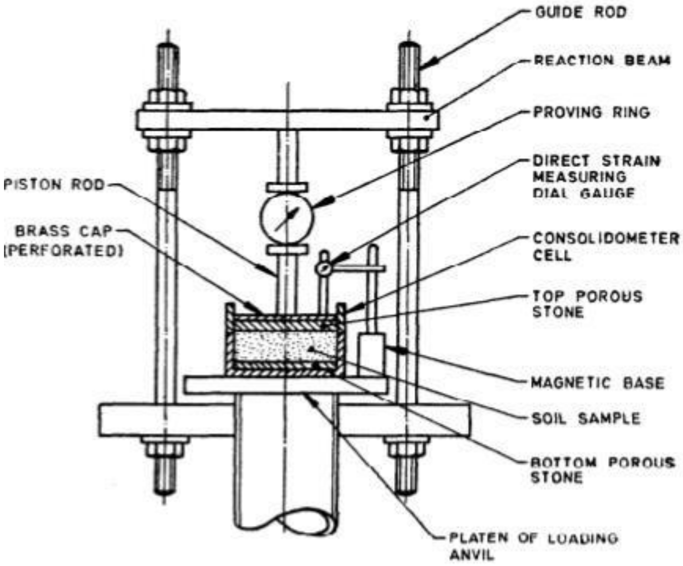


Figure 3.9 Measuring Swelling Pressure In The Constant Volume Method

SWELL PRESSURE (constant volume method)
The consolidation specimen ring with the specimen shall be kept in between two porous stones saturated in boiling water providing a filter paper between the soil specimen and the porous stone.
The loading block shall then be positioned centrally on the top of the porous stone. This assembly shall then be placed on the platen of the loading unit
The load measuring proving ring tip attached to the load frame shall be placed in contact with the consolidation cell without any eccentricity. A direct strain measuring dial gauge shall be fitted to the cell. The specimen shall be inundated with distilled water and allowed to swell.The swelling of the specimen with increasing volume shall be obtained in the strain measuring load gauge. To keep the specimen at constant volume, the platen shall be soadjusted that the dial gauge always the original reading. This adjustment shall be done at every
0.1 mm of swell or earlier.

CALCULATION
final and initial dial readings of the proving ring give total load in terms of division which when multiplied by the calibration factor gives the total load. This, when divided by the cross-sectional area of the soil specimen, gives the swell pressure expressed in kN/rn2 (kgf/ cm2).
Area = π/4 D2 = 28.27
Volume= π/4 D2h = 56.54

load = proving ring constant* proving ring reading
swell pressure = load/area

Soil	Proving ring reading		Dial gauge reading		Proving ring constant(kg/div)	Load(kg)	Swell pressure(kg/cm^2)	Moisture content(%)
	initial	final	initial	final				
Black cotton soil	13(0)	161	4(0)	4(24)	0.18	28.98	1.025	34.39
bentonite	3(0)	482	3(0)	3(30)	0.18	86.76	3.06	53.37

IV**. COMPARISION OF RESULTS AND DISCUSSIONS**

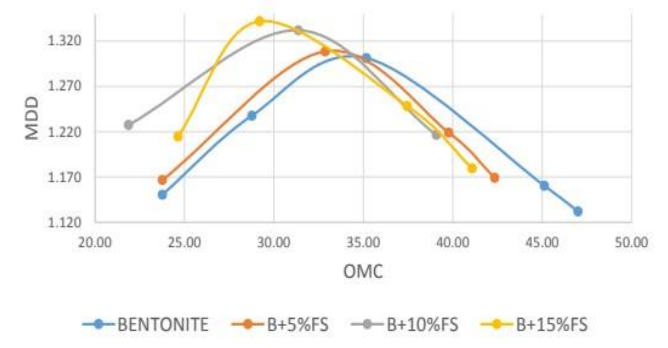


fig4.2 COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %FS

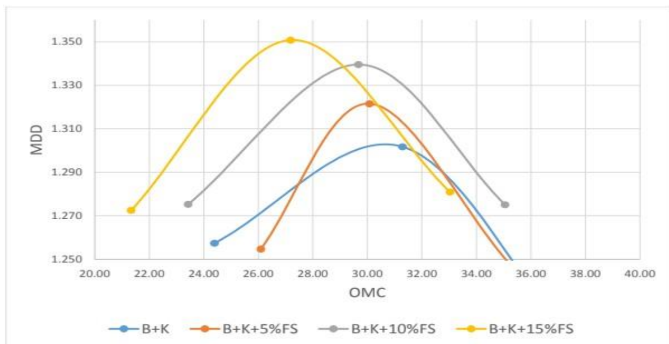


Fig4.3 COMPACTION CURVE FOR B+K+(0,5,10,15) %FS

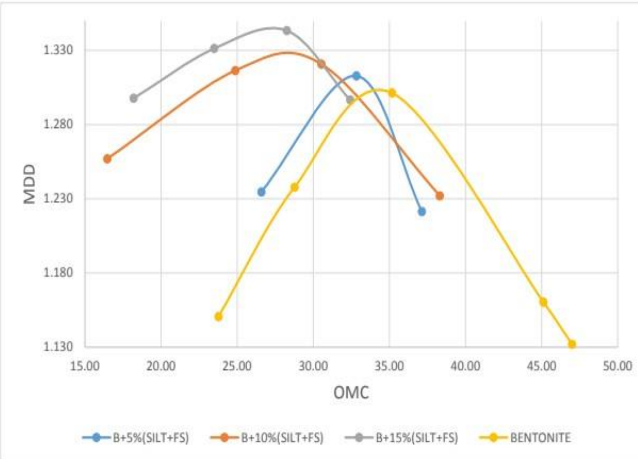


Fig 4.4 COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %(SILT+FS)

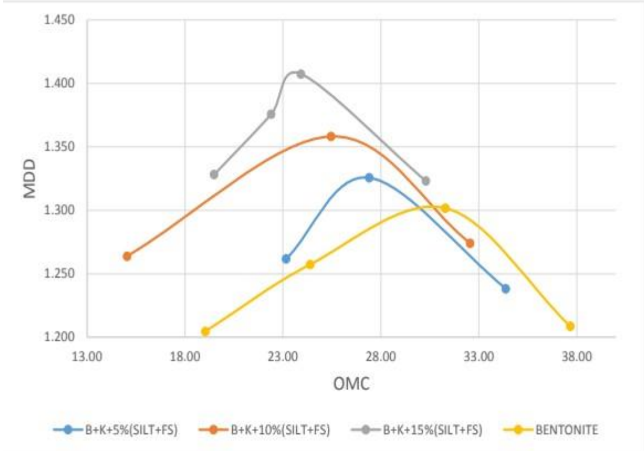


Fig 4.5 COMPACTION CURVE FOR BENTONITE+K+(0,5,10,15) %(SILT+FS)

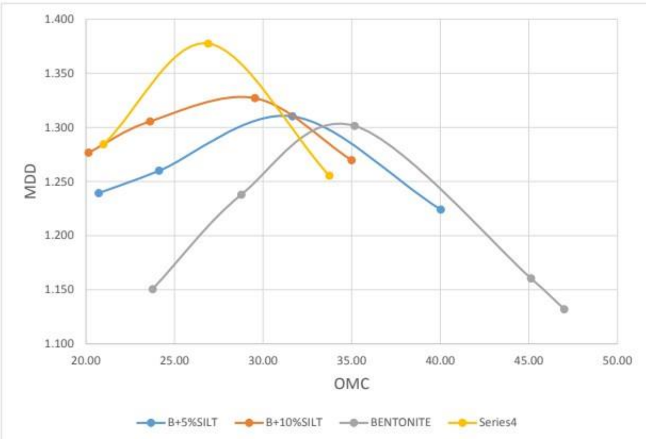


Fig 4.6 COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %SILT

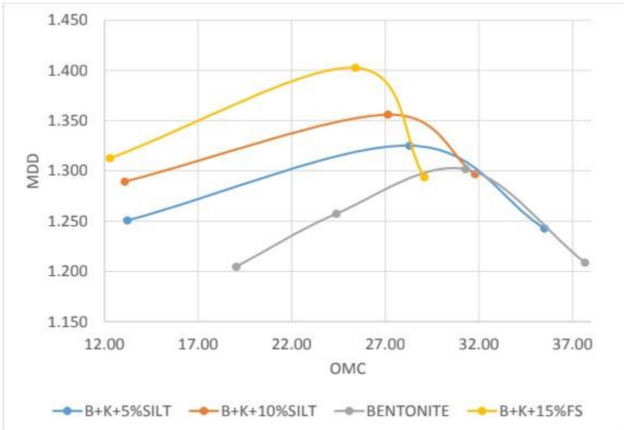


Fig 4.7 COMPACTION CURVE FOR BENTONITE+K+(0,5,10,15) %SIL

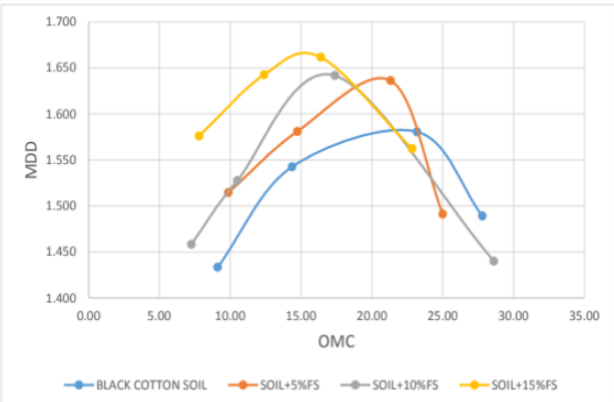


FIG 4.8 COMPACTION CURVE FOR BLACK COTTON SOIL+(0,5,10,15) %fs

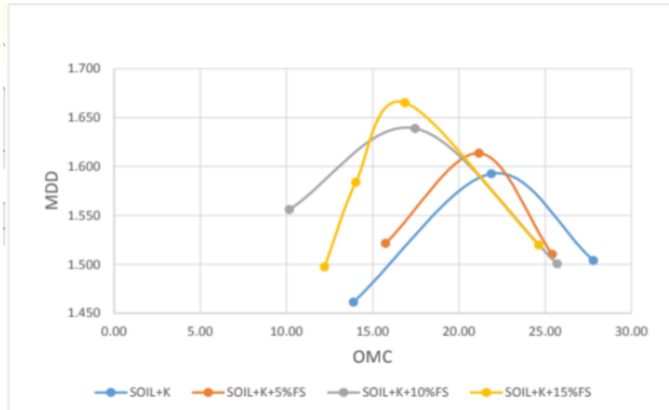


Fig 4.9 COMPACTION CURVE FOR BLACK COTTON SOIL+K+(0,5,10,15) %FS

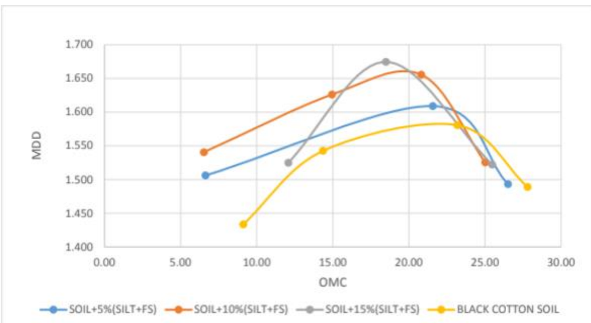


Fig 4.10 COMPACTION CURVE FOR BLACK COTTON SOIL+(0,5,10,15) %(SILT+FS)

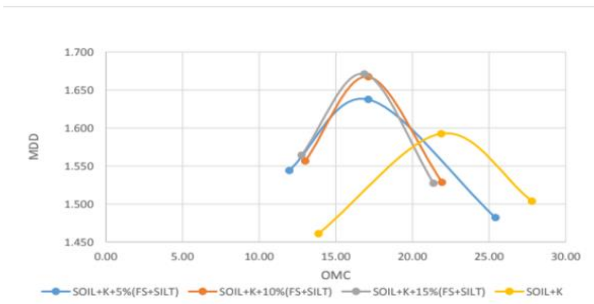


Fig 4.11 COMPACTION CURVE FOR BLACK COTTON SOIL+K+(0,5,10,15) %(FS+SILT)

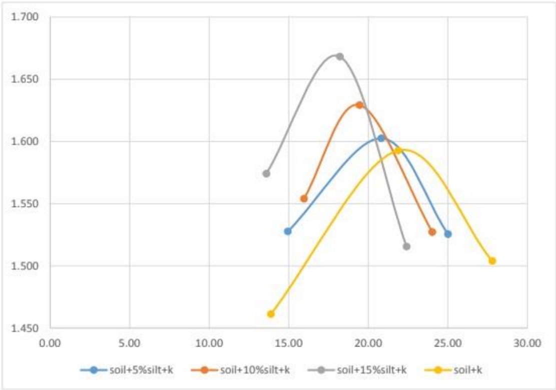
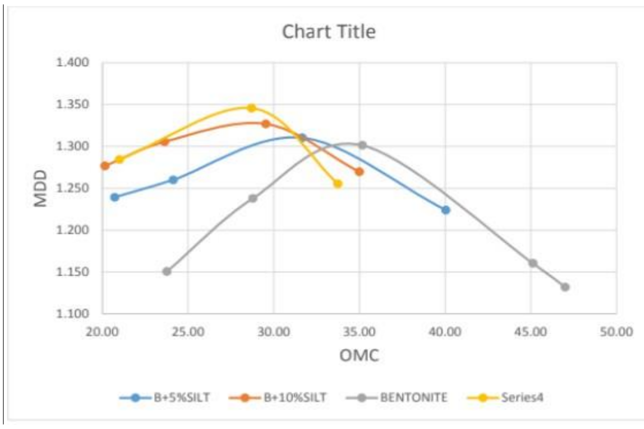


Fig 4.12COMPACTION CURVE FOR BLACK COTTON SOIL+K+(5,10,15) %SILT



BENTONITE

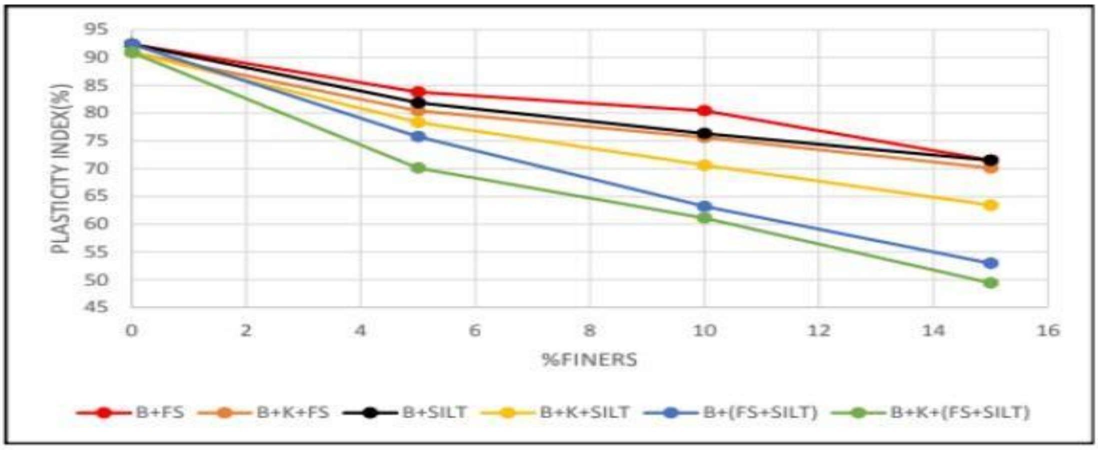


fig 4.14 (0,5,10,15) % FINERS V/S PLASTICITY INDEX CHART

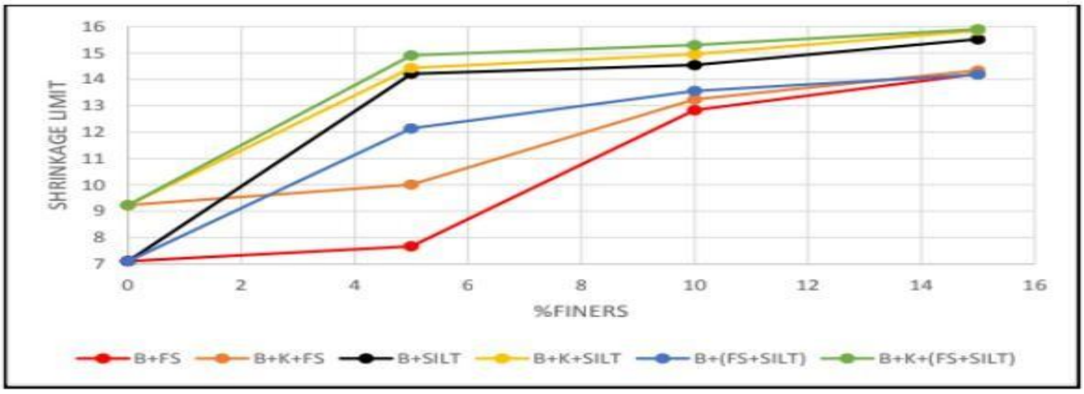


fig 4.15(0,5,10,15) % FINERS V/S SHRINKAGE LIMIT

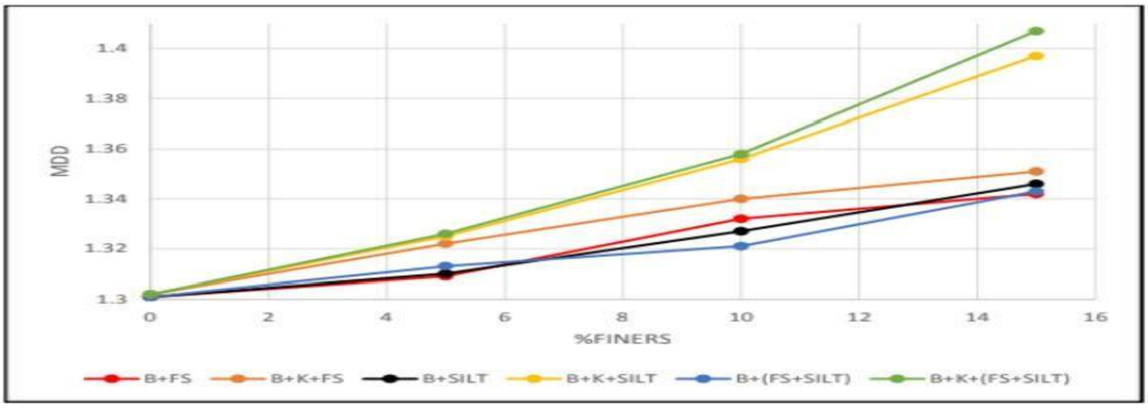


Fig 4.16 (0,5,10,15) %FINERS V/S MAXIMUM DRY DENSITY

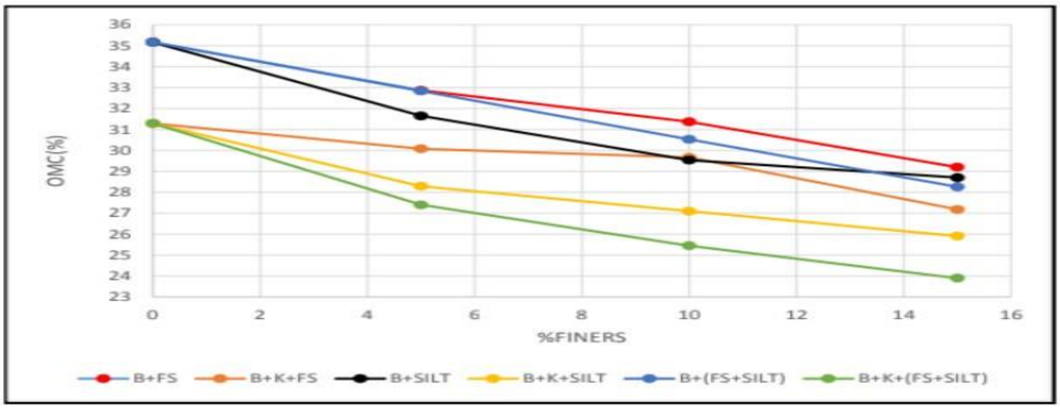


Fig 4.17(0,5,10,15) % FINERS V/S OPTIMUM MOISTURE CONTENT

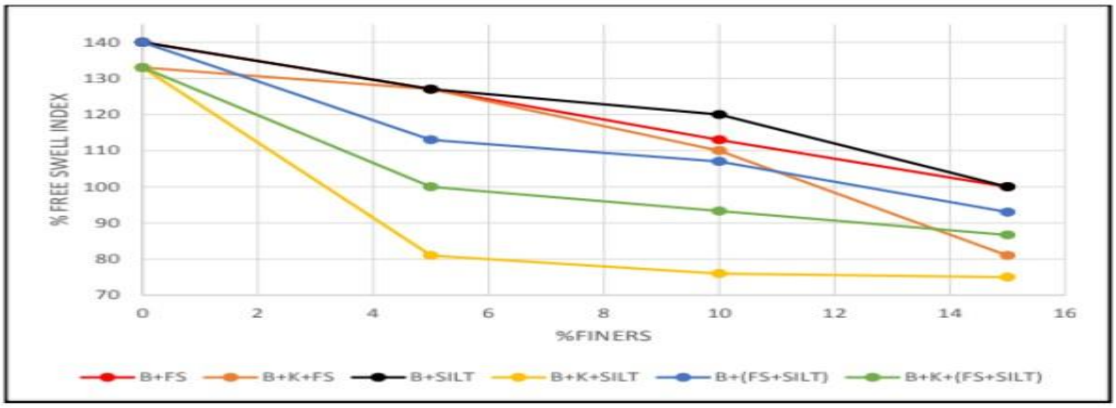


Fig 4.18 (0,5,10,15) % FINERS V/S FREE SWELL

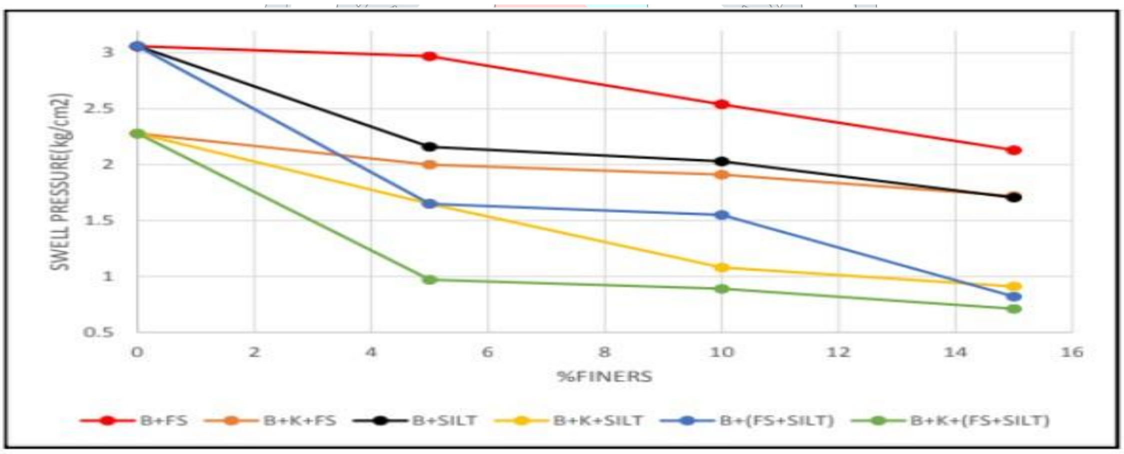


Fig 4.19 (0,5,10,15) % FINERS V/S SWELL PRESSURE

BLACK COTTON SOIL

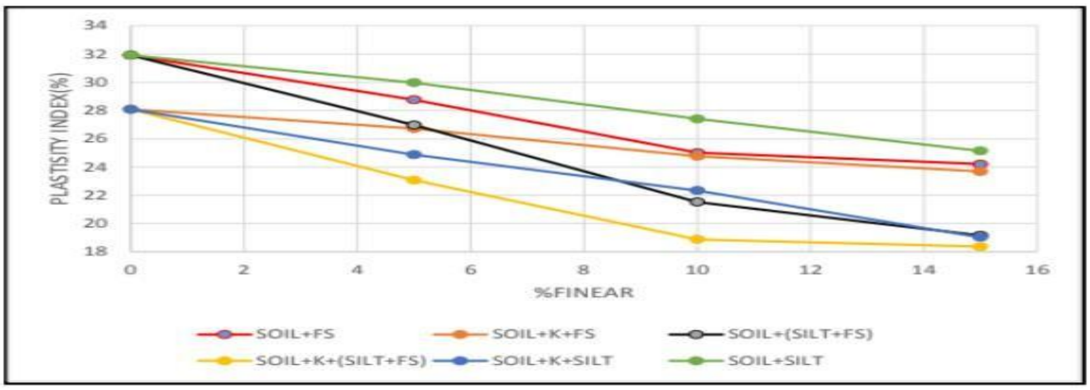


Fig 4.20 (0,5,10,15) % FINERS V/S PLASTISITY INDEX(%)

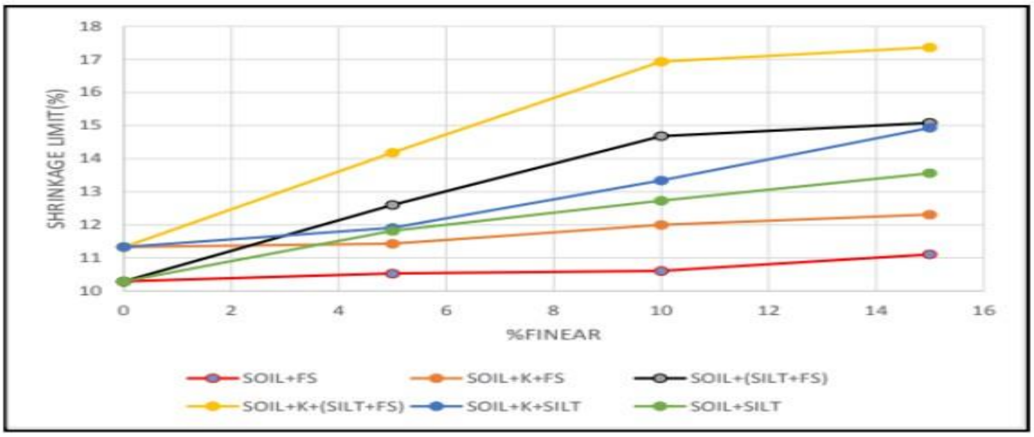


Fig 4.21 (0,5,10,15) % FINERS V/S SHRINKAGE LIMIT (%)

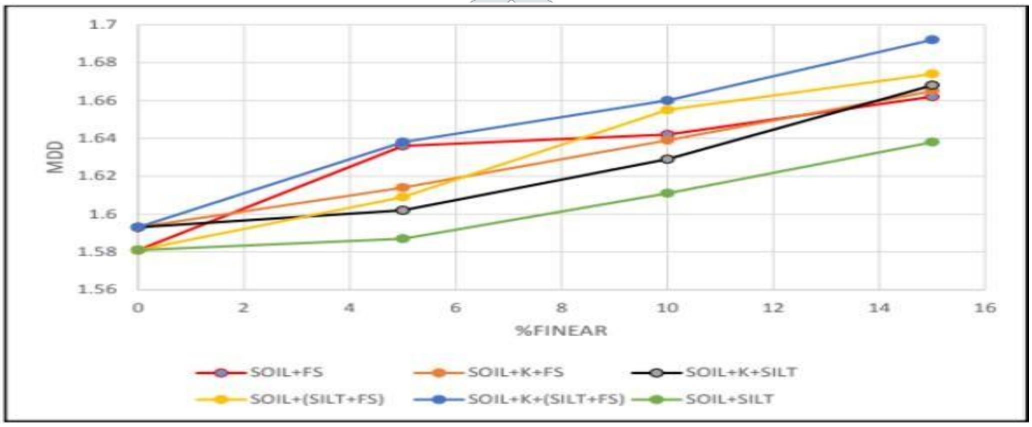


Fig 4.22 (0,5,10,15) % FINERS V/S MAXIMUM DRY DENSITY

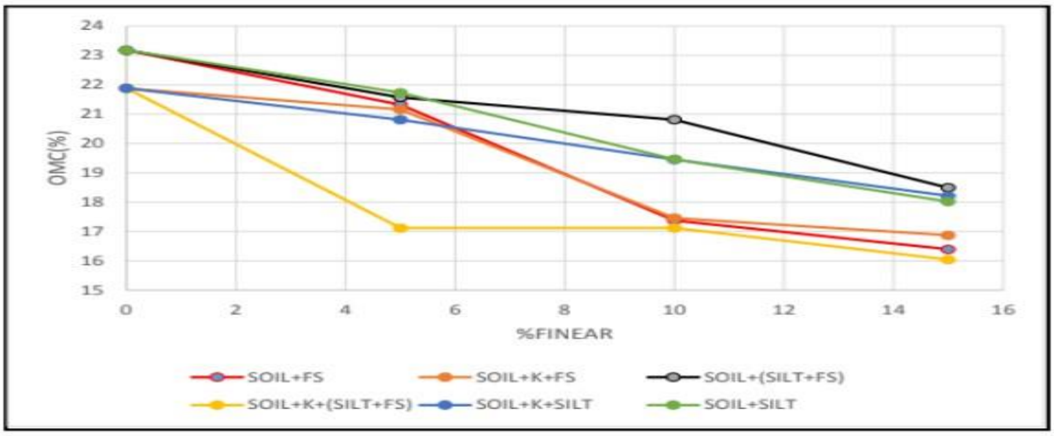


Fig 4.23 (0,5,10,15) % FINERS V/S OPTIMUM MOISTURE CONTENT (%)

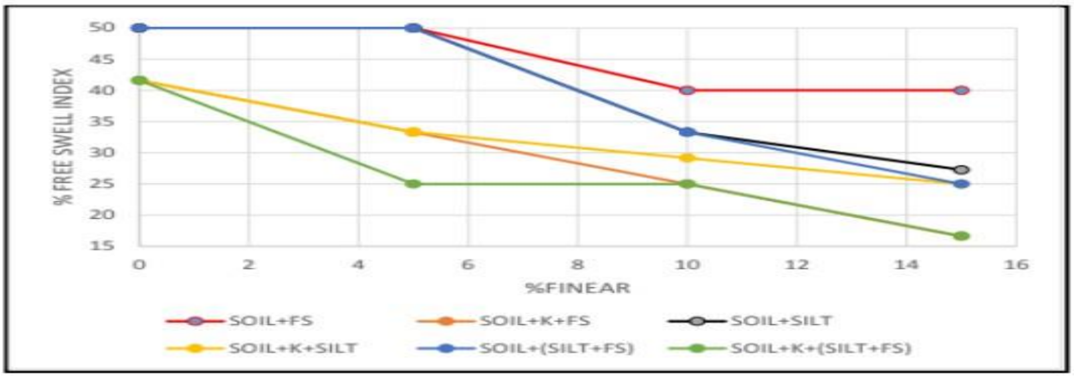


Fig 4.24 (0,5,10,15) % FINERS V/S %FREE SWELL INDEX

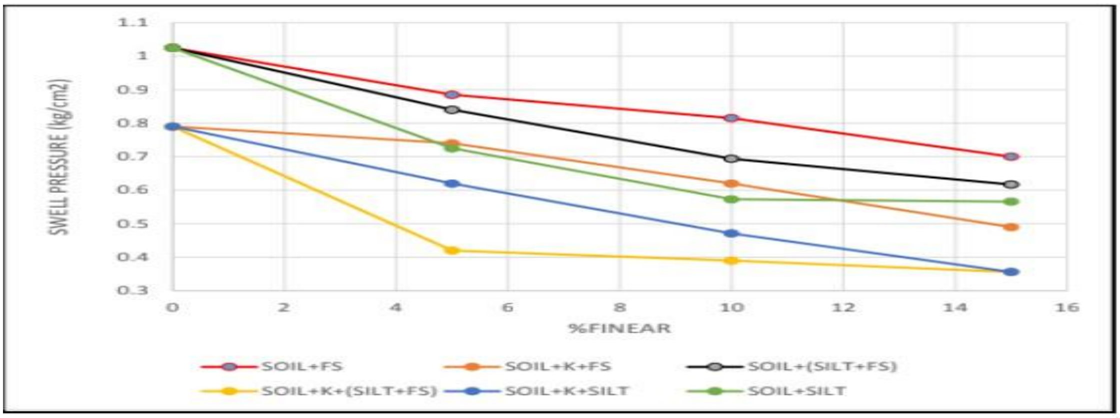


Fig 4.25 (0,5,10,15) % FINERS V/S SWELL PRESSURE

V. CONCLUSIONS

In this study to compare swelling behaviour of expansive soil in present of varying percentage of silt, fine sand, silt+fine sand.it also study effects of adding potentially low swelling soils.This present study provides following conclusions;

1. On addition of (silt, fine sand, (silt+fine sand)) & kaolinite + (silt, fine sand, (silt+fine sand), the basic index properties, such as liquid limit and plasticity index was found to be decreasing & shrinkage limit was found to be increasing.

2. Effect of addition of (silt, fine sand, (silt+fine sand)) & kaolinite + (silt, fine sand,(silt+fine sand) were also observed on compaction curves by increasing values of MDD and gradual decrease in OMC.

3. It was found that in bentonite adding 15%(silt+fine sand) reduce free swell & swell pressure93 & 0.82kg/cm2 & 10% kaolinite+ 15% of bentonite is replaced by (silt+fine sand) free swell & swell pressure respectively 86.6 & 0.71kg/cm2

4. black cotton soil adding adding 15% (silt+fs) reduce free swell & swell pressure 25 & 0.617kg/cm2 & 10%kaolinite + 15% of black cotton soil is replaced by (fine sand+silt) free swell & swell pressure respectively 16.6 &0.356kg/cm2.

5. It was concluding that reduction of combine soil (silt+fine sand) is more than individual soil. & non expansive soil is more effective for reduction of swelling behavior of expansive soil instead of finer particles.

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