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# EFFECT OF POLYSTER FIBRES AND FLY ASH ON PROPERTIES OF BLACK COTTON SOIL

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***ABSTRACT***

*In India, expansive soils are black cotton soil. The name' Black Cotton' as on agricultural origion. The black cotton soil is a type of expansive soil with high plasticity and can retain moisture through the dry season which is why they are valuable for growing crops. It exhibits low bearing capacity, low permeability and high volume change due to presence of montmorilonite minerals in its metrological content. Therefore prior to construction of a road and other engineering structures on such subgrade. It is important either replace it with no expansible soil or make it suitable for construction. Replacing the existing soil might not be a feasible option therefore the best possible option is to stabilize the existing soil with suitable stabilizers. The process of soil stabilization helps to achieve the required strength in as soil needed for the construction work. There are many soil improvement techniques either chemical or mechanical. They may classified as a ground reinforcement , ground improvement and ground treatment.*

***Keywords: Ground improvement techniques,Polyster fibers,Specific gravity,Plastic limit,liquid limit,MDD &OMC.***

## I. INTRODUCTION

In India, expansive soils are black cotton soil. The name 'Black Cotton' as on agricultural origin. The black cotton soil is a type of expansive soil with high plasticity and can retain moisture through the dry season which is why they are valuable for growing crops. It exhibits low bearing capacity, low permeability and high volume change due to presence of montmorilonite minerals in its metrlogical content. Therefore prior to construction of a road and other engineering structures on such subgrade. It is important either replace it with no expansible soil or make it suitable for construction. Replacing the existing soil might not be a feasible option, therefore the best possible option is to stabilize the existing soil with suitable stabilizers. The process of soil stabilization helps to achieve the required strength in as soil needed for the construction work. There are many soil improvement techniques either chemical or mechanical. They may classified as a ground reinforcement, ground improvement and ground treatment.

Soil stability is one of the most important topics in geotechnical engineering practices. With frequent failure of soil mass, whether it is on slope or level ground have proved to be costly in terms of both life and property. Reinforcing soil using tension resisting elements is an attractive means of improving performance of the soil in cost effective manner. Various soil stabilization techniques including fiber reinforcement have been in use for a while and results in some of them is quite satisfactory. Whether of the Soil reinforcement has been introduced in the field of geotechnical engineering in order to improve the properties of ground soil. Soil reinforcement is an effective and reliable technique

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for improving strength and stability of slopes, soil stability etc. Addition of fibers can be used as a reinforcement for improvement and modification in engineering properties of soil.

Soil reinforcement has been introduced in the field of geotechnical engineering in order to improve the properties of ground soil. Soil reinforcement is an effective and reliable technique for improving strength and stability of slopes, soil stability etc. Addition of fibers such as coir fiber,tyre chips, glass fiber,polyster fiber a reinforcement can be used for improvement and modification in engineering properties of black cotton soil.

## II. EXPERIMENTAL PROGRAMME

### 2.1 Soil Sample Used

Natural black cotton soil was collected from behind K.V.N.Naik college of Engineering near Gangapur road, Nasik district in Maharashtra state. The soil was excavated from a depth of 1m from the natural ground level. The soil is dark grey to black in color. The obtained soil was air dried, pulverized manually and passing through 425 micron and 4.75 mm IS sieve was used. The soil has a property of high volume change and develops cracks in summer. This soil predominantly consists of montmorillonites the principal clay mineral.

**Table 2.1 Properties of soil**

| Sr. No. | Parameter | Symbol or Percentage | Values obtained |
|---|---|---|---|
| 1. | Specific gravity | Gs | 2.58 |
| 2. | Natural water content | % | 11 |
| 3. | Liquid limit | % | 63 |
| 4. | Plastic limit | % | 41.58 |
| 5. | Shrinkage limit | % | 12.35 |
| 6. | Plasticity index | Ip | 21.42 |
| 7. | MDD | g/cc | 1.627 |
| 8. | OMC | % | 19.20 |
| 9. | Swelling Index | % | 37 |
| 10. | Colour | | Black |

### 2.2 Soil Reinforcement Used

Polyester fibers for present investigation were collected from Reliance Industries limited. Rajasthan Jaipur. It was packed in cartons and palletized for protection during transportation. Fibers were purchased 450 gm plastic cartons

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**Properties of polyester fibers are as follows**

| Sr. no. | Properties | Polyester fiber | Unit |
|---|---|---|---|
| 1 | Shape | Triangular | |
| 2 | Cut length | 10 | mm |
| 3 | Effective diameter | 20-40 | microns |
| 4 | Specific gravity | 1.35 | - |
| 5 | Melting point | 250-265 | Deg.C |
| 6 | Tensile Strength | 4-6 | GPa |
| 7 | Young's Modulus | >5000 | Mpa |

**2.3 Fly Ash Used**

Fly ash for present investigation was collected from Eklahare Thermal Power station at free of cost for proper bonding of black cotton soil and polyster fibers.Fly ash may be act as a iinert material in the soil reinforcement.

**2.4 Specific Gravity Test**

The specific gravity of a soil is used in the phase relationship of air, water and solids in a given volume of the soil. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of same volume of distilled water at a stated temperature. Specific gravity was found out with the help of pycnometer. Specific Gravity was conducted using pycnometer according to IS 2720 (Part 2) 1964. Specific gravity was calculated with help of formula

$$G = \frac{M_2-M_1}{(M_2-M_1) - (M_3-M_4)}$$

Where,

$M_1$ = Empty weight of Pycnometer

$M_2$ = Weight of pycnometer + Weight of B.C.soil+polyster fibers+fly ash

$M_3$ = Weight of pycnometer +Weight of B.C.soil+polyster fibers+fly ash+Water

$M_4$ = Weight of pycnometer + Water

The specific gravity value of soil mixed various % of polyster fibers and Fly ash

| Type of soil | Specific gravity value % |
|---|---|
| B.C.S.+0.25%Fibers+20%Flyash | 2.57 |
| B.C.S.+0.50%Fibers+20%Flyash | 2.57 |
| B.C.S.+0.75%Fibers+20%Flyash | 2.55 |
| B.C.S.+1.00%Fibers+20%Flyash | 2.50 |
| B.C.S.+1.25%Fibers+20%Flyash | 2.48 |
| B.C.S.+1.50%Fibers+20%Flyash | 2.44 |

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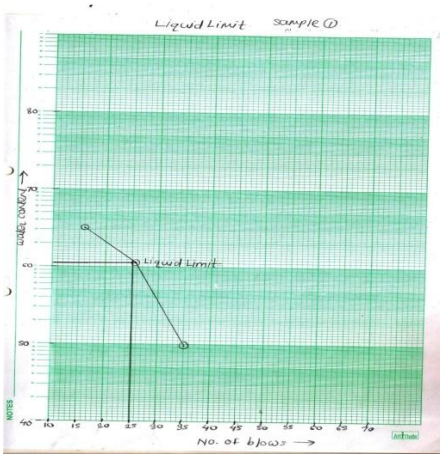
2.5%,With the inclusion of 0.25% fibers,it was observed that there is increase in specific gravity value.The specific gravity value increases or remains same with the inclusion of fiber content upto 0.50% and with the further inclusion of fibers beyond 0.50% decrease in specific gravity value observed.

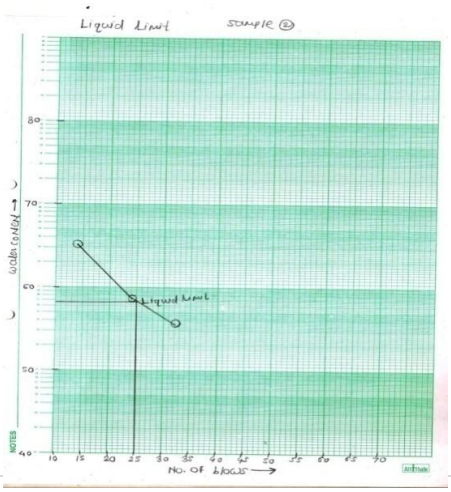
**2.5 Liquid limit (LL)**

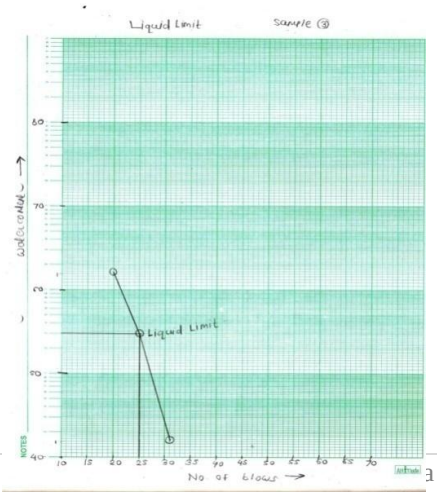
The liquid limit is defined as the minimum moisture content at which soil will flow upon application of very small shearing force or it is the moisture content corresponding to the boundary between liquid and plastic states of soil mass. Plastic limit was conducted as per I.S.2720 (Part 5) 1985. Cassagrandes apparatus was used to determine the liquid limit**.**

The Liquid limit value of soil mixed various % of polyster fibers and Fly ash

| Type of soil | value % |
|---|---|
| B.C.S.+0.25%Fibers+20%Flyash | 62.12 |
| B.C.S.+0.50%Fibers+20%Flyash | 61.14 |
| B.C.S.+0.75%Fibers+20%Flyash | 55.01 |
| B.C.S.+1.00%Fibers+20%Flyash | 51.48 |
| B.C.S.+1.25%Fibers+20%Flyash | 51.25 |
| B.C.S.+1.50%Fibers+20%Flyash | 52.10 |



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**2.6Plastic Limit(PL)**

The plastic limit is the moisture content at which the soil remains in plastic state or it is the water content at which the soil is just begins to crumble when rolled into a thread of 3 mm diameter. Plastic limit was conducted as per IS2720 (Part-6)-1972.

The Plastic limit value of soil mixed various % of polyster fibers and Fly ash

| Type of soil | value % |
|---|---|
| B.C.S.+0.25%Fibers+20%Flyash | 39.50 |
| B.C.S.+0.50%Fibers+20%Flyash | 39.23 |
| B.C.S.+0.75%Fibers+20%Flyash | 35.33 |
| B.C.S.+1.00%Fibers+20%Flyash | 28.85 |
| B.C.S.+1.25%Fibers+20%Flyash | 31.65 |
| B.C.S.+1.50%Fibers+20%Flyash | 30.61 |

**2.7 Plasticity Index(IP)**

Plasticity index was determined by subtracting plastic limit from liquid limit, hence plasticity index for experimental soil was calculated for different proportions of fiber content and fly ash.

$I_{P=}P_L.L_L$

The Plasticity index of soil mixed various % of polyster fibers and Fly ash

| Type of soil | value % |
|---|---|
| B.C.S.+0.25%Fibers+20%Flyash | 22.62 |
| B.C.S.+0.50%Fibers+20%Flyash | 21.91 |
| B.C.S.+0.75%Fibers+20%Flyash | 19.68 |
| B.C.S.+1.00%Fibers+20%Flyash | 22.63 |
| B.C.S.+1.25%Fibers+20%Flyash | 19.60 |
| B.C.S.+1.50%Fibers+20%Flyash | 21.49 |

With inclusion of 0.25%fibers plasticity index increases to 21.42 without inclusion of any reinforcement upto0.5% inclusion of fibers which increases plasticity of soil and at 0.75% & 1.25% inclusion of fibers reduces the plasticity index and improves swelling property of soil.

**2.8Compaction Test**

Compaction tests were performed as per IS 2720(Part7)to determine moisture density relationships of highly compressible black cotton soil without fiber and then with fibers.Amount of fibers varies from 0.25% to 1.50%.The compaction curves obtained are as shown in fig.

| Type of soil | MDD g/cc | OMC % |
|---|---|---|
| B.C.S.+0.25%Fibers+20%Flyash | 1.59 | 18.87 |
| B.C.S.+0.50%Fibers+20%Flyash | 1.62 | 17.15 |
| B.C.S.+0.75%Fibers+20%Flyash | 1.64 | 19.42 |
| B.C.S.+1.00%Fibers+20%Flyash | 1.71 | 18.02 |

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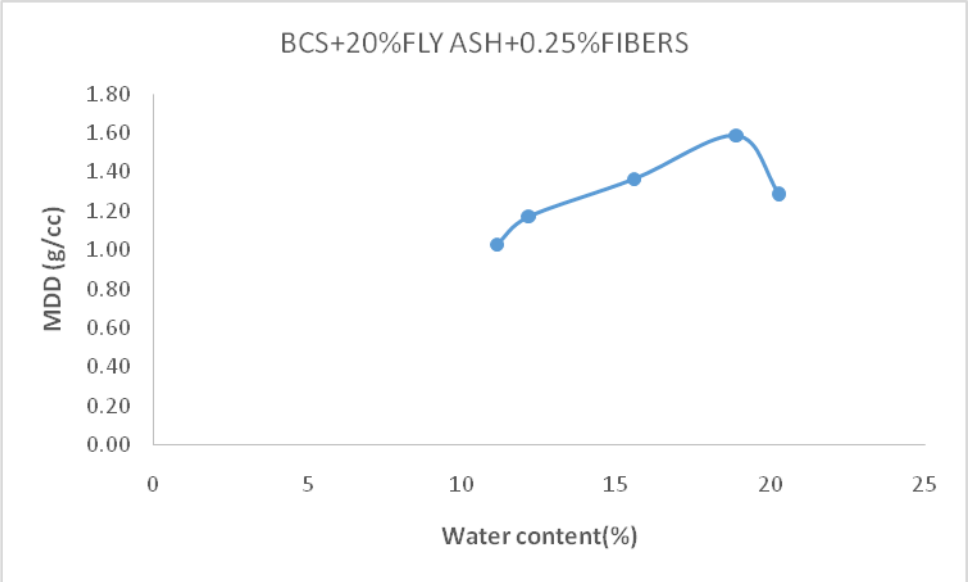
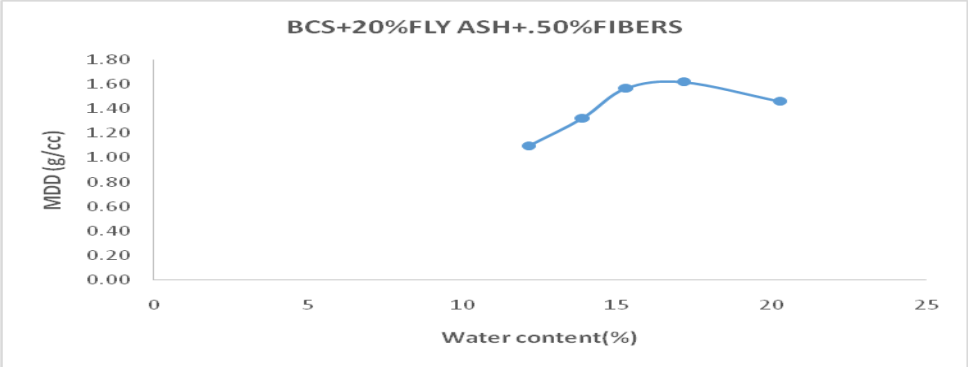
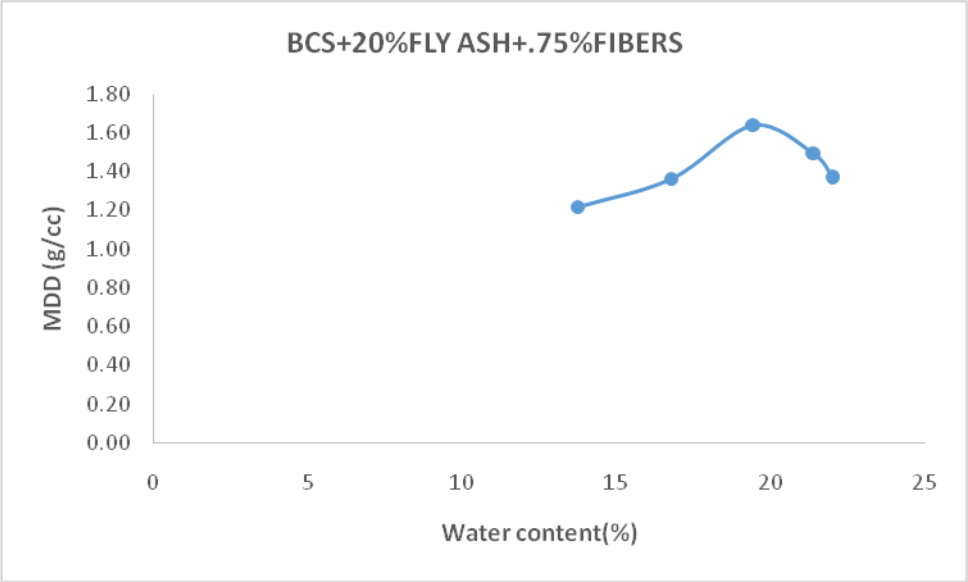
| | | |
|---|---|---|
| B.C.S.+1.25%Fibers+20%Flyash | 1.68 | 17.89 |



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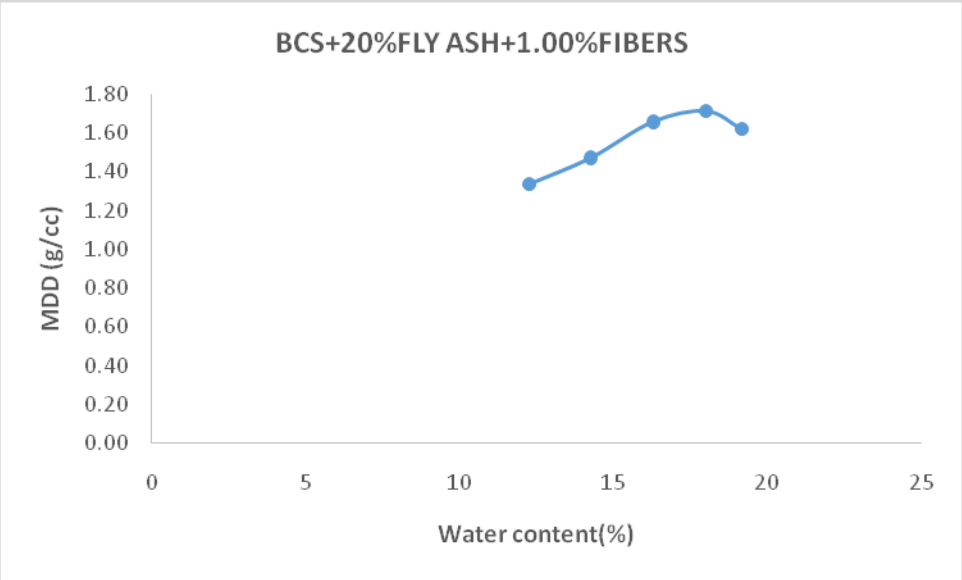


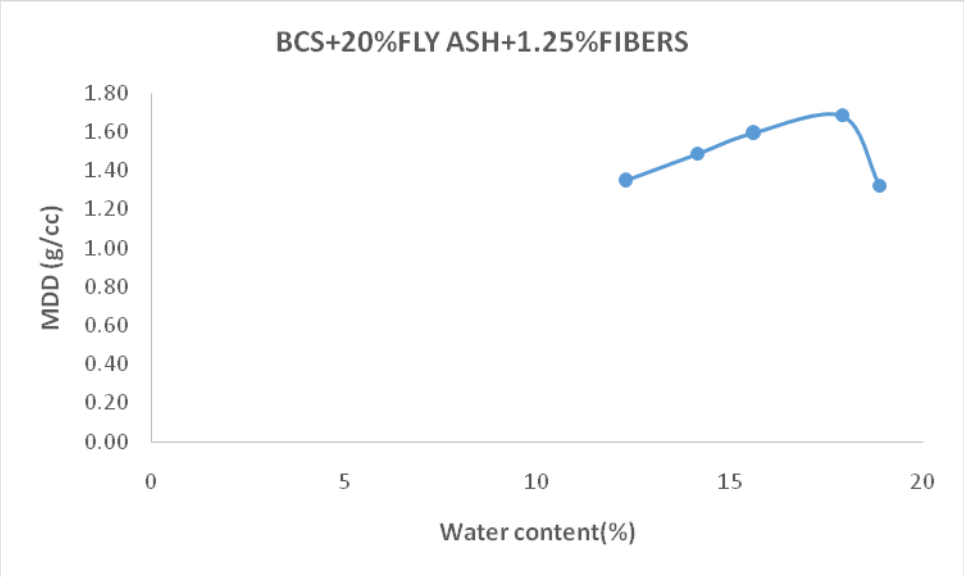


The result of compaction tests shows that MDD of 1.62gm/cc is independent of amount of of fibers and fly ash.Thus the effect of fiber inclusions on the MDD is negligible and OMC slightly increases for 0.75% inclusion of fibers.For remaining proportions of fibers it decreases compare to19.40% of without inclusion of fibers.

## III. CONCLUSIONS

Following conclusions are drawn from the above study.

The result of compaction tests shows that MDD of 1.62gm/cc is independent of amount of of fibers and fly ash.Thus the effect of fiber inclusions on the MDD is negligible and OMC slightly increases for 0.75% inclusion of fibers.For remaining proportions of fibers it decreases compare to19.40% of without inclusion of fibers.

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**Future Scope**

In future by adopting same proportions of fibers and fly ash with black cotton soil to study the effects of adding polyster fibers on the strength characteristics of highly compressible black cotton soilfor sub grade CBR tests will be conducted.Also unconfined compressive strength test will be conducted for different proportions of fiber inclusions with fly ash to find out UCS value of soil at different proportions.

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