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EFFECT OF FLY ASHON THE PROPERTIES OF BLACK COTTON SOIL:A REVIEW

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ABSTRACT

To full fill the infrastructural need of increasingpopulation, small multi-storey buildings, express highways, high speed rail tracks, new bridges, airports etc. are required to construct. In many places it is not feasible due to the presence of Black cotton soil or clayey soil. Black cotton soil is a problematic soil which expands by absorbing water and shrinks when the moisture is removed. This review paper represents the study of "fly ash" as a stabilizer or admixture in improving some of the properties of the black cotton soil. Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron .The aim of this review paper is to discuss the effect of fly ash on the basic engineering properties of black cotton soil such liquid limit, plastic limit, compaction, CBR value etc.

Keywords : Black Cotton Soil,Fly As, Stabilization.

I INTRODUCTION

Expansive soil are mostly found in the arid and semi-arid regions and it cover very large area of the world. It covers nearly 20% of the land in India and includes approximately the entire Deccan Plateau. Maharashtra, Andhra Pradesh, Karnataka and parts of Gujarat and western Madhya Pradesh. Black cotton soil is a type of expansive soil with high plasticity and can maintain water throughout the summer season. It is expansive in nature and possess high swelling and shrinkage properties. It is hard as long as it is dry but loses its stability almost completely when it becomes wet, Again when it became dry shows a lot of cracks on its surface. So we have to find stabilization methods which are economic and improves the problematic nature of black cotton soil. One of the finest method to deal with this problem is to stabilize this soil with fly ash. Thermal power plants, cement, steel and paper industries all over the world contribute enormous quantity of fly ash every year. Environmentally safe disposal of fly ash has necessitated the exploration of innovative and cost effective methods of utilizing the fly ash in many fields. The major uses of fly ash mostly arise out of its pozzolanic property which can be used for stabilization of soils. Pozzolanic fly ashes can be advantageously made use of to improve the geotechnical properties of black cotton soil. Fly ash has been successfully used as stabilizing agent for different soils by various researchers, both in laboratory and also in field (Amos and Wright 1972) reported the effect of mixing fly ash with clayey and loamy soils on their geotechnical properties. The properties of soil are improved by cat ionexchange, flocculation and pozzolonic cementation (Bell, 1988).The addition of fly ash to clayey soils reduced their plasticity and swelling characteristics (Shivapullaiah et.al.1996).

II FLY ASH

Fly Ash is an industrial waste product from thermal power plants which uses coal as fuel.It is estimated that 170 million tons of fly ash is being produced from different thermal power plants in India consuming 70 thousand acres of precious land for its disposal causing severe health and environmental hazards (Ahmad et al. 2014). There are two major classes of fly ash, class C and class F. The former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sub bituminous coal. Both the classes of fly ash are pozzolans, which are defined as siliceous and aluminous materials (ErdalCokca 2001). The micro sized fly ash mainly consists of silica, alumina and iron and the particles are generally spherical in size which makes them easy to blend and make a suitable mixture. In order to utilize fly ash in bulk quantities, ways and means are being explored all over the world. In spite of continuous efforts made by the government hardly 5-10% of the fly ash is being used for construction purpose like brick making, cement manufacturing, soil stabilization andas filling material. As the properties of fly ashes vary from place to place, there is a need to check the variability of properties for its effective utilization. Hence, before the utilization of fly ash as a construction material, it is necessary to study properties of fly ash from different sources, so that it can be used beneficially. Physical and chemical properties obtained from different studies are presented in Table 1 and Table 2. It can be seen that silica content in the fly ash is very high. Such high content of silica is reason for the pozzolonic activity.

Fig.1 Original picture of fly ash

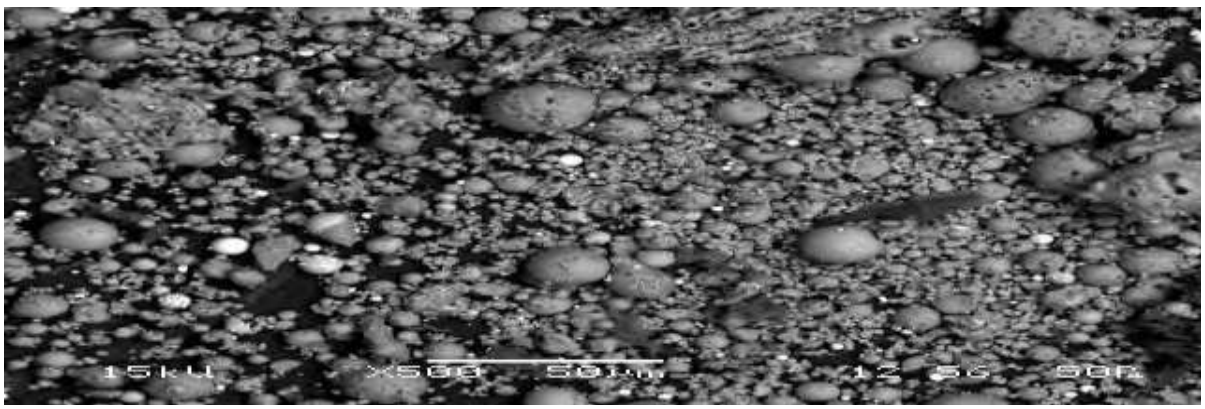

Fig.2 SEM picture of fly ash

Table.1 Physical property of Fly Ash (Mehta et al. 2013, Harkari et al. 2012, Ahmed Naseem et al. 2014)

Physical property	**Value**
Colour	Grey
Specific gravity	1.9-2.7
plasticity	Non plastic
OMC (%)	38.0 – 18.0
MDD	0.9 – 1.6
Angle of internal friction	$30^0 – 40^0$
Compression index C_c	0.05 – 0.4
Permeablity	8 x 10-6 – 7 x 10-4
Coefficient of uniformity	3.1 – 10.7

Table.2 Chemical properties of Fly Ash(Bairwa et al. 2013,Bidulabose 2013, Kalyanshetti et al. 2013)

Chemical properties (%)	**Range of values**
Silica (SiO_3)	50 - 62
Alumina (Al_2O_3)	24 - 30
Ferric oxide (Fe_2O_3)	0 - 9
Calcium oxide (CaO)	1 - 3
Magnesium oxide (MgO)	0.5 - 1
Titanium oxide (TiO_2)	0 - 0.3
Loss of ignition	1 - 19

III EFFECT OF FLY ASH ON THE PROPERTIES OF BLACK COTTON

Many laboratory tests were carried out on Black cotton soil mixed with fly ash by many national and international researchscholars and they found that the results are quite satisfactory. The effect of the fly ash on the index and engineering properties of the soil is presented in the following section

3.1 Specific Gravity

The specific gravity of soil fly ash mix decreases with the increase in the percentage of fly ash. It is found to decrease from 2.62 to 2.22 with the increase in the percentage of fly ash from 10% to 50% respectively (Hakariet al.2010)

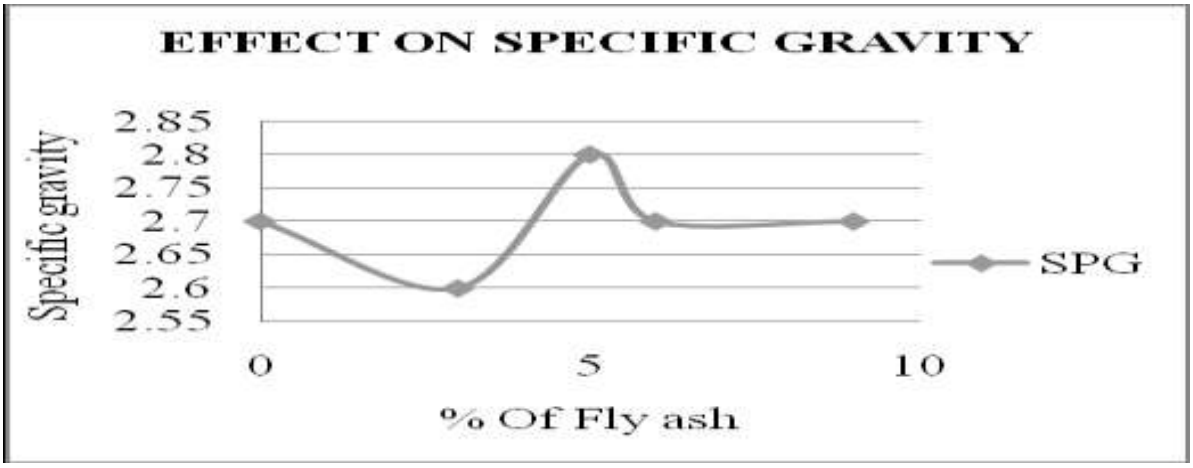

Fig 3. Variation of specific gravity

3.2 Liquid Limit

The liquid limit decreases with the addition of fly ash, showing a marginal decline up to 30% of fly ash and then decreases considerably with the addition of more than 30% fly ash (Naik et al.). Also Hakari et al.(2010), reported that the liquid limit decreases with the addition of fly ash, showing a marginal decline up to 30% of fly ash and then after decreasing considerably for 40% addition. The decrease of liquid limit due to the effect of reduction in the diffused double layer thickness as well as effect of dilution. Also Possible explanation may be related to the flocculation, and aggregation of the clay particles by addition of fly ash. Furthermore, fly ash inclusion diminished the clay size fraction of soil in view of flocculation of the clay particles by cementation.

3.3 Plastic Liquid

The addition of 10% fly ash slightly increases the plastic limit, which is due to flocculation owing to the presence of free lime in the fly ash. Further increase in the addition of fly ash results in the marginal increase of plastic limit (Naik et al.). Also (Kalyanshettiet al.2013) reported that Plastic limit increases with increase in percentage of fly ash up to 10-15% and then further almost remain constant. Similar results were found by Pravin Patel in 2014.

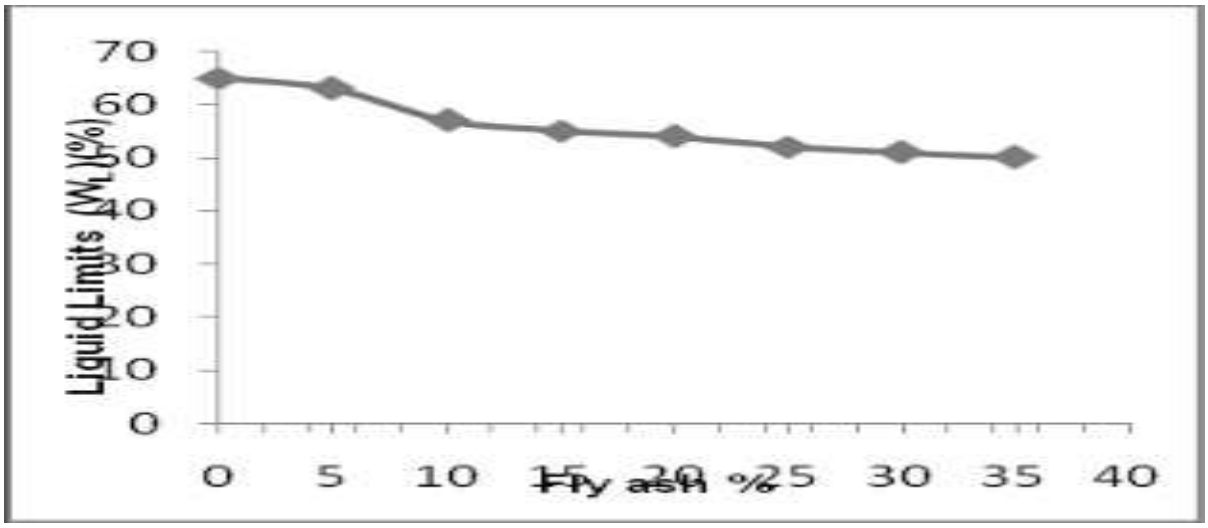

Fig 4.Variation of L.L with addition of fly ash (Kalyanshettiet al.2013)

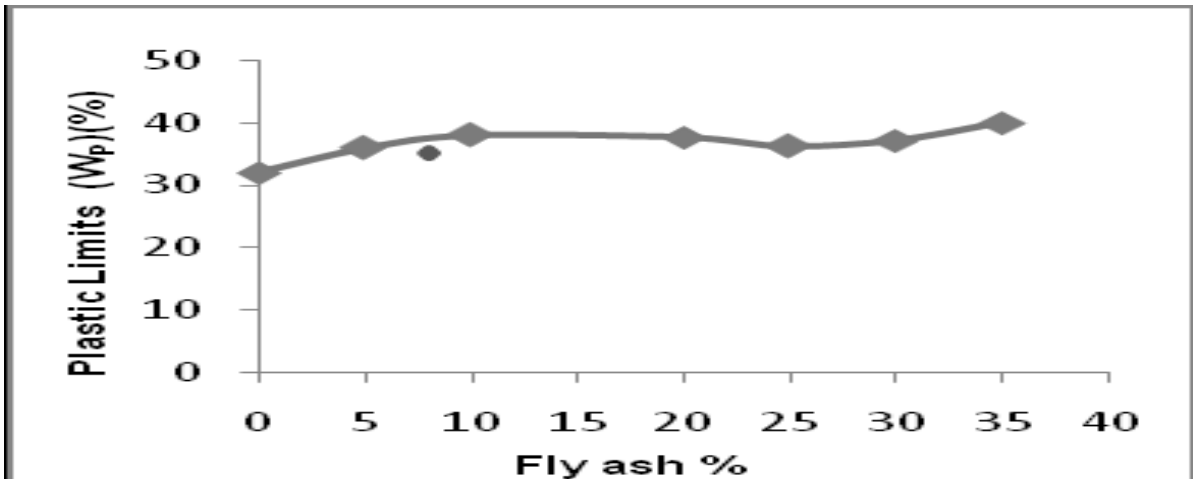

Fig 5.Variation of P.L with addition of fly ash (Kalyanshettiet al.2013)

3.4 Shrinkage Limit

The addition of fly ash increases the shrinkage limit of black cotton soil. It increases with increasing percentages of fly ash. The gradual increase is observed up to 30% of fly ash added and is considerable on further addition of fly ash (Naik et al.). Similar results were found by Pravin Patel in 2014.

3.5 Compaction Parameters (OMC and MDD)

In B.C. soil Maximum Dry Density increases slightly up to 20% of fly ash, and then it decreases. It is shown that for depressive clays the Maximum Dry Density first increases and then decreases with the increase in fly ash content (Hardaha et al. 2013). Hayder A. Hasan (2012) has reported that Maximum dry density decreased with increasing fly ash content, and the optimum moisture content increased with added fly ash content. it is observed that there is a steady increase in Optimum Moisture Content up to 30% and beyond 30% a decrease in Optimum Moisture contents were observed. As the percentage of Fly ash increases a steady decrease in dry density values

were observed (S.Hemanth Kumar et al.2013). Addition of fly ash beyond 20% to 25%, is not significant (Kalyanshetti et. al.)

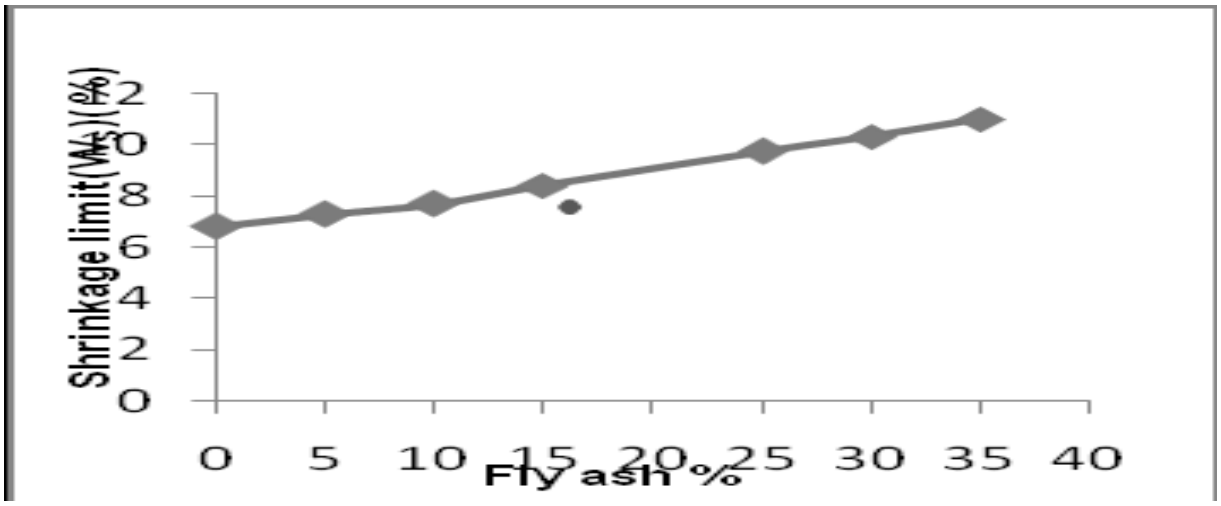

Fig 6.variation of S.L with addition of fly ash (Kalyanshetti et al.2013)

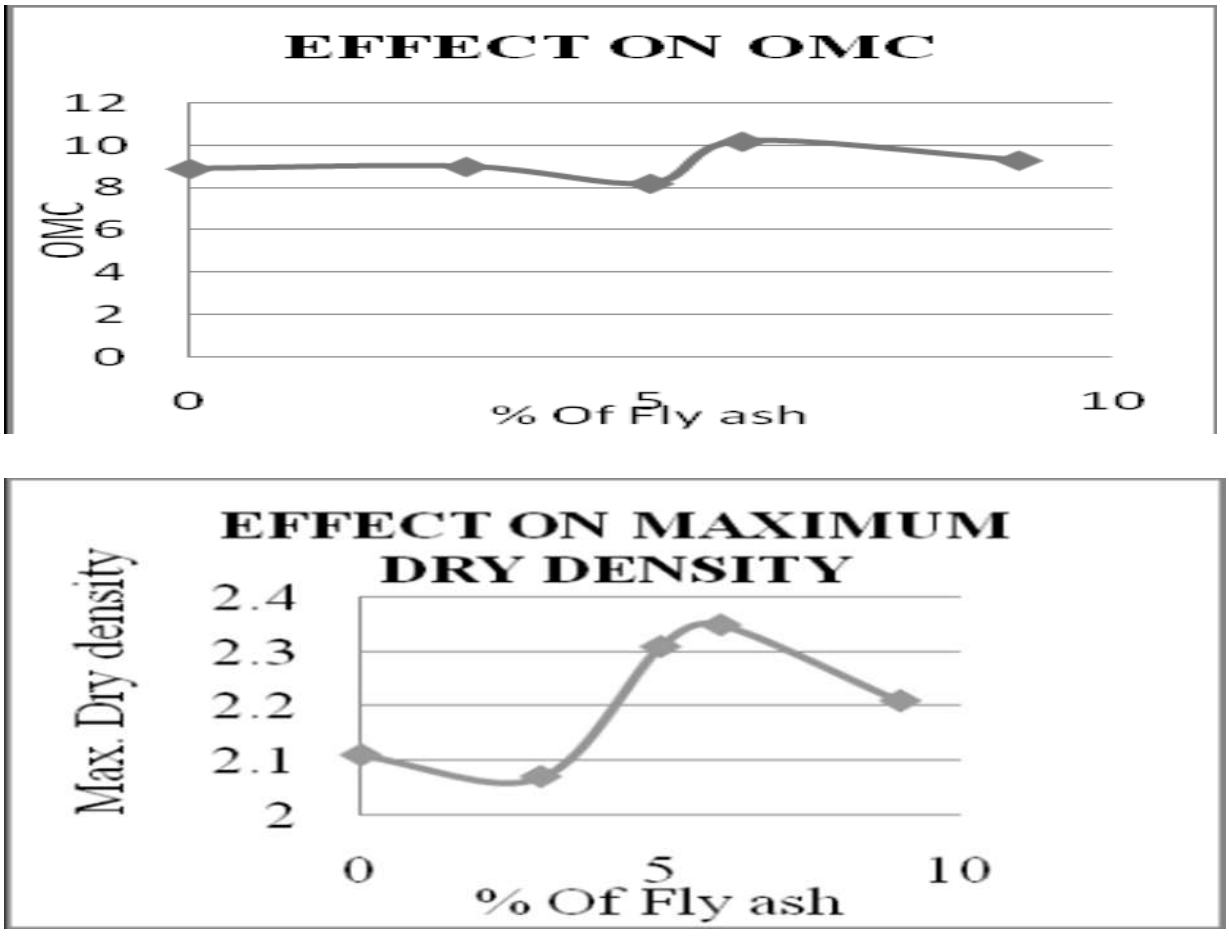

Fig 7. OMC & MDD Curves for fly ash mixed with black cotton soil (Karthik et. al. 2014)

3.6 California Bearing Ratio (CBR)

The low CBR of the black cotton soil is attributed to its inherent low strength which is due to the dominance of the clay fraction. Addition of fly ash to the black cotton soil increases gradually the CBR of the mix up to a peak value of addition of 30-40% of fly ash (Hakari et.al. 2012). CBR value of Black Cotton soil also increase with increasing varying % fly ash. The optimum percentage of fly ash at 20% for gave the best result for sub grade soil (Pravin Patel, 2014). The CBR values of clay-fly ash mixes, tested under un-soaked conditions, shows peaks at 20% and 80% ash content (Bidula Bose, 2012).Similar results were obtained by Pandian (2004).

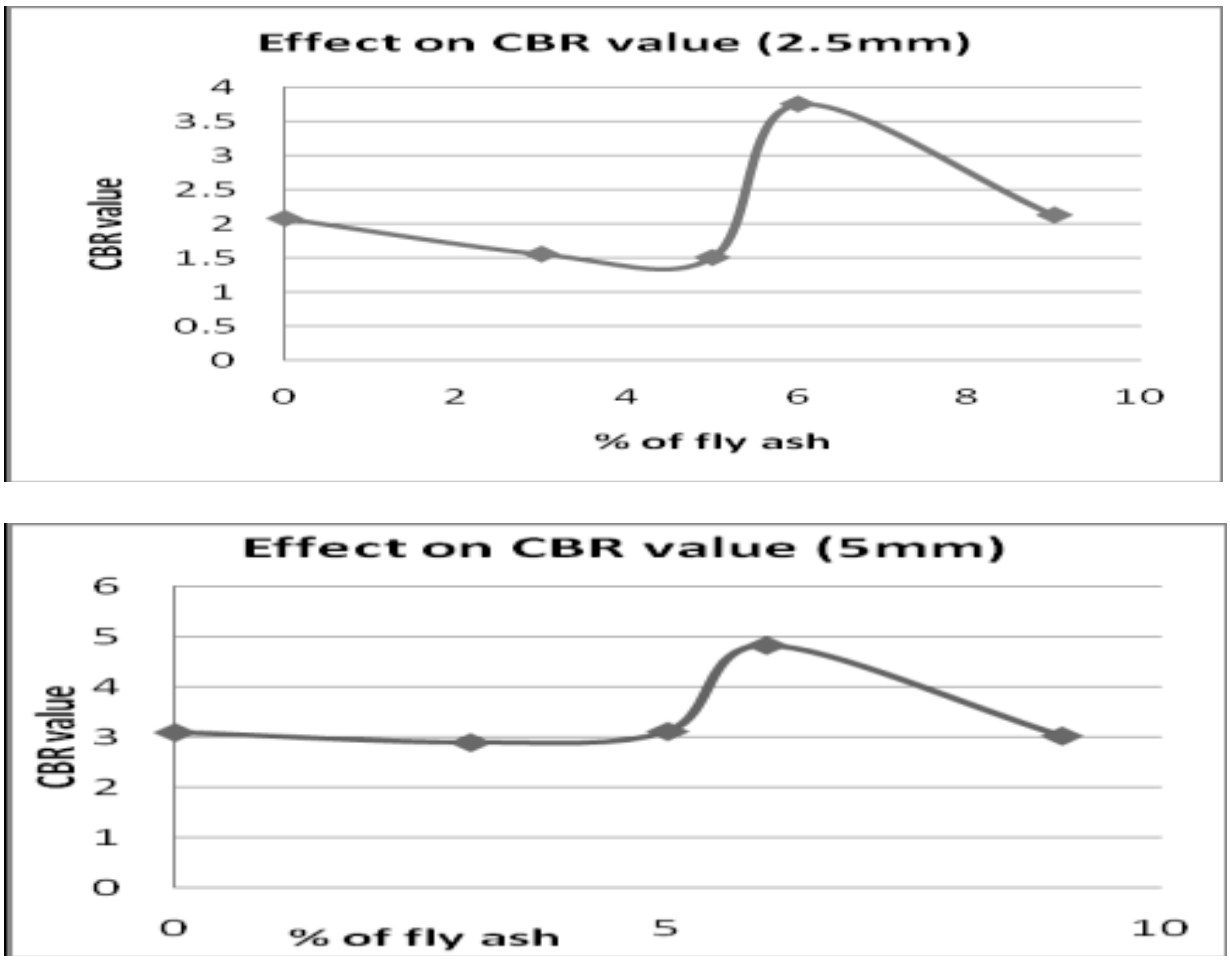

Fig 8. CBR curves for fly ash (Karthik.S.et. al. 2014)

3.7 Unconfined Compressive Strength(U C S)

It is seen that the strength increases on addition of small percentage of 10% or 20% of fly ash. Further increase in fly ash percentage shows no considerable increase in the strength. This is due to the probable disturbance of soil skeleton and consequent reduction in cohesion (Hakari et. al.2012). UCS value of Black Cotton soil also increase with varying % of fly ash (Pravin Patel, 2014). Maximum Unconfined compressive strength was obtained at 20% fly ash mix with clay and further addition of fly ash reduces the strength (Bidula Bose, 2014).

3.8 Swelling Characteristics

Up to the addition of 20% to 25% of Fly ash. Swelling Pressure reduces with higher rate, after that it reduces with slower rate so addition of fly ash beyond 20% to 25% is not significant (Hakariet al.2010).Swell percentage and swell pressure decrease with addition of fly ash. Both swell % and swell pressure decrease at samples containing 15% fly ash (HayderA.Hasan, 2012) .The Free swell index is reduced by about 50% by the addition of 20% Fly ash (Phanikumar et.al. 2004).

IV CONCLUSION

- The addition of fly ash reduces the plasticity characteristics of black cotton soil. The liquid limit, plastic limit, plasticity index, linear shrinkage decreased drastically and shrinkage limit increased with the addition of fly ash.
- The maximum dry density increases up to 20% fly ash mix, and then gradually decreases whereas the optimum moisture content decreased with increase in fly ash content.
- CBR value of Black Cotton soil also increase with increasing varying % fly ash.CBR value increases with higher rate up to 25-30 % of fly ash and then with slower rate.
- Unconfined compressive strength attains peak value between 20 and 30 % of fly ash, beyond which the increase in the strength is marginal. The addition of fly ash to expansive soil reduces the free swell and swelling pressure. For the expansive soil used both free swell and swelling pressure were reduced by 40-50% at 20% fly ash. At higher percentage of fly ash rate of reduction in free swell and swelling pressure gradually decreased.
- Both Swell percentage and swell pressure decrease with addition of fly ash.

From the above observations it can be concluded that Fly ash has good potential for use in geotechnical applications. The relatively low unit weight of fly ash makes it well suited for placement over soft or low bearing strength soils. Its low specific gravity, freely draining nature, ease of compaction, insensitiveness to changes in moisture content, good frictional properties, etc. can be beneficially used in the construction ofembankments, roads, reclamation of low-lying areas, fill behind retaining structures, etc.

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