Effect of Fly-Ash on Engineering Characteristics of Silty Soil

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Abstract

In India, silty soil are available in many states and have poor supporting capacity. Main objective of this research is to utilize the industrial waste like fly-ash to improve the engineering characteristics of the silty soil. Soil samples blended with the fly-ash from 0% to 50% of dry weight of the soil. Samples were prepared and results showed a significant increase in soaked California Bearing Ratio (CBR) value. Liquid limit decreased from 30.66% to 23.31% and plasticity index decreased from 10.21% to 6.29%. DFS of silty soil reduced from (31%) to (5%). From the compaction tests result decreased in maximum dry density (MDD) from 1.71 gm/cc to 1.55gm/cc and increased in optimum moisture content (OMC) from 20.4% to 24.31%. In this investigation it can be seen that fly-ash has a potential to improve the engineering characteristics of silty soil.

Keywords: Fly-Ash, Silt Soil, Index Properties, Engineering Characteristics

I. INTRODUCTION

Silt is granular material of size somewhere between sand and clay whose material origin is quartz and feldspar. Silt may occur as a soil or as sediment mixed in suspension with water (also known as a suspended load) in a body of water such as a river. It may also exist as soil deposited at the bottom of a water body. Silt has a moderate specific area with a typically non-sticky, plastic feel. Silt usually has a floury feel when dry and a slippery feel when wet. Silt soil is the soil washed downstream by river and streams and normally deposited on field during flood. It normally is high is nitrogen and phosphates. It is very productive form of soil. Fly-ash is a industrial waste obtained from thermal power plant and has a bulk in quantity. This research paper provides the effect of the fly-ash on index and engineering properties like LL, PL, PI, DFS, compaction characteristics, CBR of the silty soil.

II. LITERATURE REVIEW

Many researchers have worked on use of industrial waste for soil stabilization. A study on strength characteristics of expansive soil-fly ash mixes at various moulding water content has been studied by Satyanarayana at al. (2013). It has been reported that fly-ash increases the strength and decreases the swelling characteristics and 20-30% fly-ash needed to stabilize expansive soil. Bhuvaneshwari and robinson (2005) studied the stabilization of expansive soil using fly-ash and they concluded that the workability is maximum with 25% of fly-ash in soil. Mehta at al(2013) studied stabilization of black cotton soil by fly-ash and reported that the plasticity index decreases with increases the amount of fly-ash content. BROOKS (2009) studied "soil stabilization with fly-ash and rice husk ash" and reported that the rice husk ash (RHA) content of 12% and a fly-ash content of 25% are recommended for strengthening the expansive sub grade soil while a fly-ash content of 15% is recommended for blending into RHA to form a swell reduction layer .

Fly-ash is an industrial waste obtained from thermal power plants by burning of coal. The test result showed a significant improvement in compaction and CBR characteristics. And fly-ash is found to be an effective waste material for the stabilization of expansive soil.

III. MATERIALS AND METHODS

silty soil used in this study was mixed with the fly-ash in the different proportions and a series of the laboratory tests were conducted on samples containing various percentages of the fly-ash i.e. 0%, 10%, 20%, 30%, 40% and 50% by weight of the dry soil. Following test were conducted as per relevant IS code of practice:

- Liquid limit.
- Plastic limit.
- Plasticity index.
- Differential free swell test.
- Compaction characteristics.

– California bearing ratio (CBR) test.

1) FLY-ASH: Fly-ash is used as stabilization material in this research. Fly-ash was obtained from, Beersinghpur thermal power plant, district sehdol, Madhya Pradesh.
2) SILT SOIL: Silt soil involved in this study was brought from Lalpur water treatment plant, Rampur, Jabalpur (M.P.). The silt soil is classified as ML(silt of low compressibility).

The physical characteristics of Black cotton soil are presented in table-1.

Table – 1
Physical characteristics of Silt soil

S.No.	*PROPERTIES*	*Test values*
1.	*Liquid limit% (LL)*	*30.6*
2.	*Plastic limit% (PL)*	*20.4*
3.	*Plasticity index%(PI)*	*10.2*
4.	*Optimum moisture content (%)*	*20.4*
5.	*Maximum dry density (gm/cc)*	*1.71*
6.	*California Bearing Ratio Test (%)*	*3.0*
7.	*Differential free swell test (%)*	*32*

IV. TEST RESULTS

Based on the result obtained from various tests conducted on silt soil, fly-ash mixes. The variation in various index and engineering properties of the silt soil are discussed below. Liquid limit decreased from 30.6% to 23.3% and plasticity index decreased from 10.2% to 6.2%. The DFS decreases from 31% to 5%. This shows that the properties of soil are improved. Proctor compaction test results showed a increased in OMC from 20.4% to 24.31% and decreased in MDD values from 1.71 to 1.55 gm/cc with the additions of fly-ash from 0% to 50%. The maximum value of CBR obtained at 20% of fly-ash.

Various tests were conducted on Silt Soil mixed with Fly-ash in different proportions as per relevant IS code of practice. test results obtained are shown in table-2

Table – 2
Research Test Results

S.No.	*PROPERTIES*	*MF0*	*MF10*	*MF20*	*MF30*	*MF40*	*MF50*
1.	*LIQUID LIMIT*	*30.6*	*31*	*29*	*27*	*25*	*23*
2.	*PLASTIC LIMIT*	*20.4*	*22.7*	*20.2*	*18.4*	*17.5*	*17.0*
3.	*PLASTICITY INDEX*	*10.21*	*9.26*	*9.14*	*8.95*	*7.89*	*6.29*
4.	*DFS*	*32*	*23*	*18.3*	*12.7*	*8.5*	*0*
5.	*OMC*	*20.4*	*22.5*	*24.3*	*23.0*	*22.7*	*21.2*
6.	*MDD*	*1.71*	*1.69*	*1.65*	*1.62*	*1.59*	*1.55*
7.	*CBR*	*3.0*	*5.2*	*7.1*	*6.0*	*4.1*	*3.6*

Where:MF0=siltysoil+0%fly-ash,MF10=siltysoil+10%fly-ash,MF20=siltysoil+20%fly ash,MF30=siltysoil+30%fly,MF40=siltysoil+40 Fly-ash,MF50=siltysoil+50%fly-ash.

Variation of different engineering properties are shown in figure 2 to 7

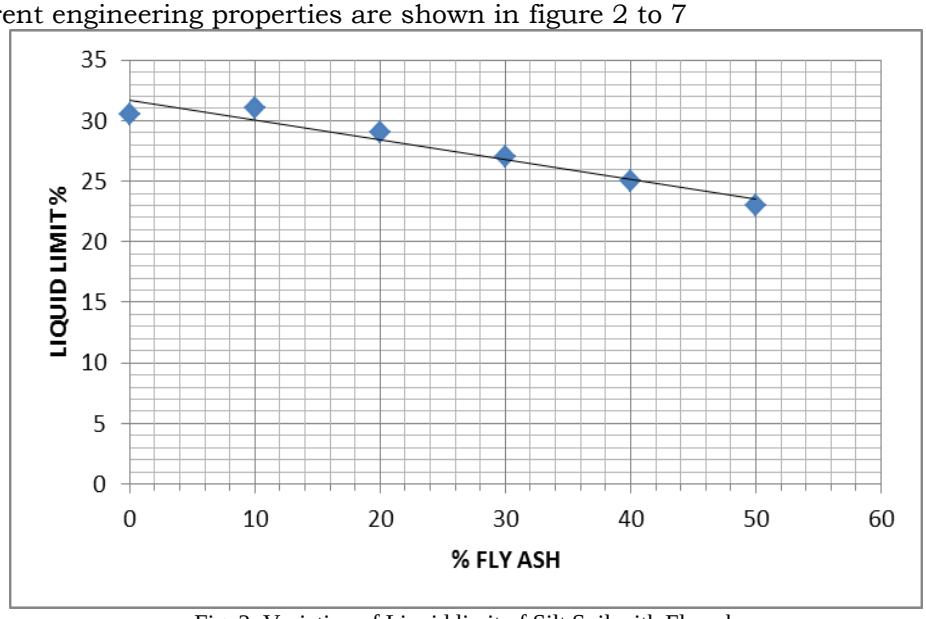

Fig. 2: Variation of Liquid limit of Silt Soil with Fly-ash

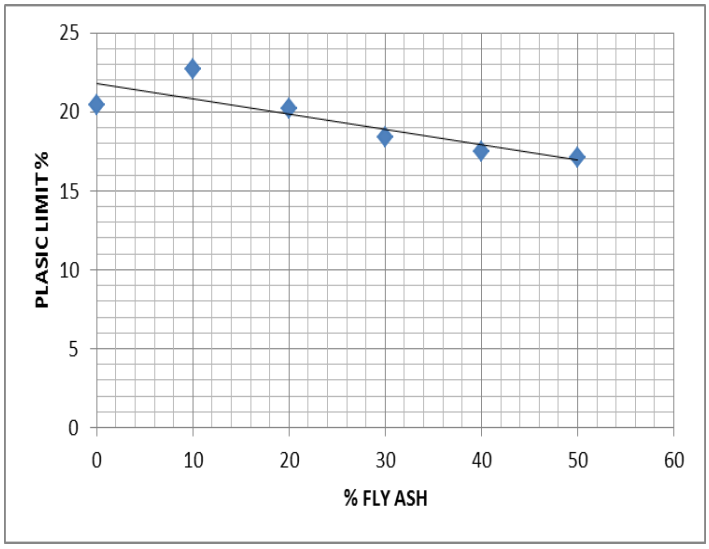

Fig. 3: Variation of Plastic limit of Silt Soil with Fly-ash

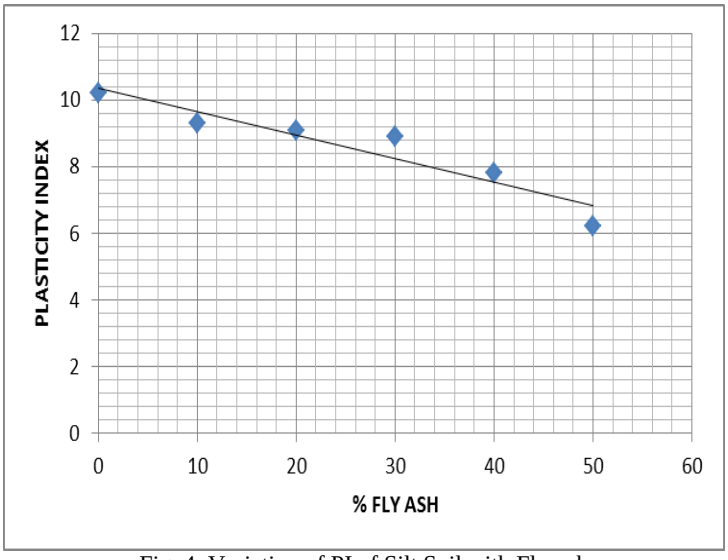

Fig. 4: Variation of PI of Silt Soil with Fly-ash

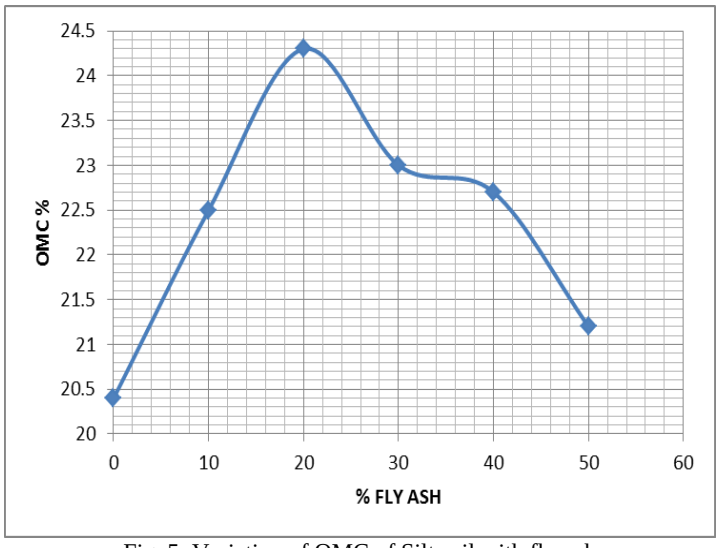

Fig. 5: Variation of OMC of Silt soil with fly-ash

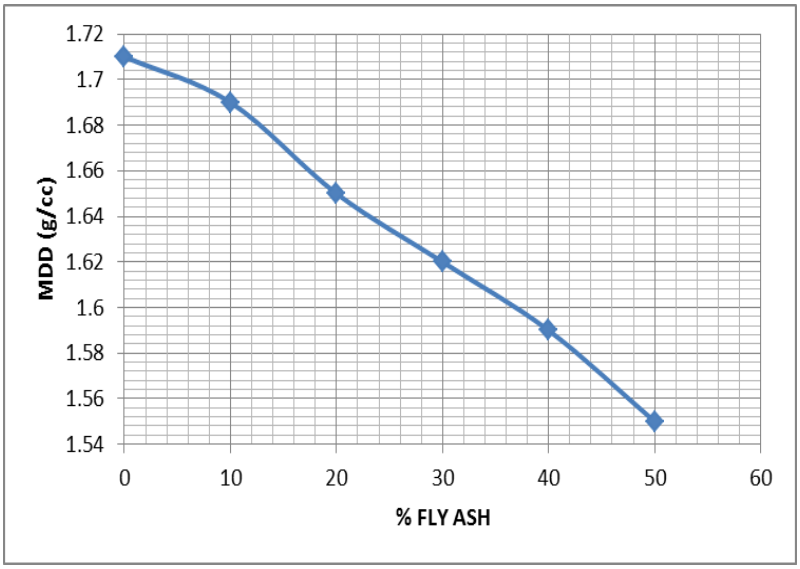

Fig. 6: Variation of MDD of Silt Soil with Fly-ash

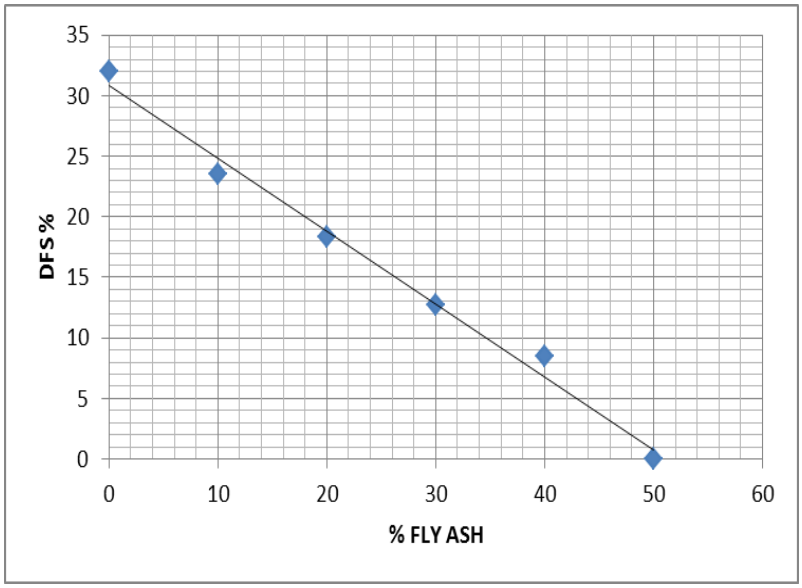

Fig. 7: Variation of DFS of Silt soil with Fly-ash

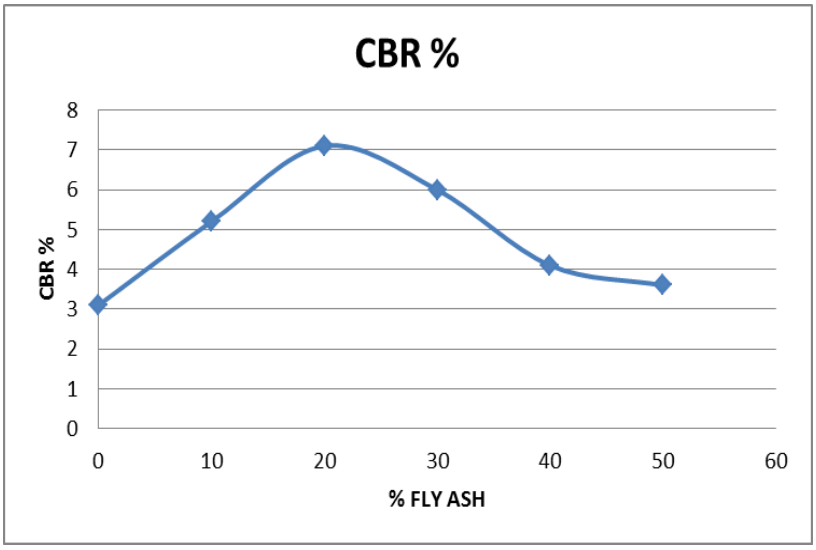

Fig. 7: Variation of CBR of Silt soil with Fly-ash

V. CONCLUSION

Based on the laboratory test conducted on silty soil and fly-ash mixes, The following conclusion can be drawn:

1) Addition of fly-ash into the silty soil has changed the proctor compaction parameters. The OMC of the silt soil has increased and Maximum dry density (MDD) decreased with the addition of fly-ash.
2) There is significant decrease in swelling characteristics of the soil. The DFS values are reduced from 31% to 5%, indicating that the degree of expansiveness has reduced from moderate to low.
3) Soaked CBR values have also increased with the addition of fly-ash content. The addition of 20% fly-ash into the silty soil giving the maximum CBR value.
4) There is a gradual decreased in liquid limit from 30.6% to 23.3% .
5) Addition of fly-ash also decreased the plasticity index from 10.2% to 6.2%.

From the above research it can be concluded that the industrial waste like fly-ash has a potential to modify the engineering behaviour of silty soil and to make it suitable in many of the geotechnical applications.

REFERENCES

[1] Arora, S and aydilek, A.H.,"Class F Fly-ash –Amended soils as Highway Base Material ,"ASCE Journals of materials, 2005, vol. 17, No.6, pp 640-649.
[2] Bhuvaneshwari S., Robinson R.G. and Gandhi S.R.(2005):"Stabilization of expansive soil using fly" Indian institute of technology madras, chennai-36 fly ash utilization programmme (FAUP) , TIFAC, DST, new delhi-110016 (fly ash India 2005, new Delhi).
[3] Brooks M. and Dr. Robert (2009):"Soil Stabilization with fly ash and rice husk ash" international journal of research and reviews in applied science , volume 1, Issue 3, PP-209-217.
[4] Chen, F.H. (1988),"Foundation on expansive soil", chen & Associate, Elsevier publication,U.S.A.
[5] Erdal cokca (2001) "use of class fly ashes for the stabilization of an expansive soil" Journal of geotechnical and geoenvironmental engineering vol.127 , July, PP.568-573.
[6] IS 2720 : Part 16 : 1987 Method of Test for Soil – part 16 : Laboratory Determination of CBR.
[7] IS 2720 : Part XL : 1977 Method of Test for Soils – Part XL : Determination of Free Swell Index of Soils.
[8] Katti, R.K.(1979),"Search for solution to problem in black cotton soils", First IGS annual lecture, Indian Geo-Technical journal , vol.9, pp-1-88.
[9] Misra, A."Stabilization Characteristics of Clays Using Class C Fly-ash "Transportation Research Record, 2000, Transportation Research Board, National Research Council, Washington, D.C,1611, 46-54.
[10] Pandian, N.S.Krishna, K.C.& Leelavathamma B.,(2002), Effect of fly ash on the CBR Behaviour of soils , Indian geotechnical conference, Allahabad, vol.1,PP183-186.
[11] Phanikumar B.R.,& Radhey S.Sharma(2004) "Effect of fly ash on Engg. Properties of Expansive soil" Journal of Geotechnical and Geoenvironmental Engineering vol.130, no 7, July, pp.764-767.
[12] Reyes Arleen and Miguel pando(2007): " Evalution of CFBC fly-ash for Improvement of Soft Clays" World of Coal Ash (WOCA), May 7-10, 2007, Northem kentucky, USA. Vol.13, PP-1-13.
[13] Satyanarayana P.V.V, Kumar S.Hemanth , Praveen and Kumar B.V.Suresh(2013):"A study on strength characteristics of expansive soil-fly-ash mixes at various moulding water content" international journal of recent technology and engineering (IJRTE) ISSN: 2277-3878, volume-2 , Issue-5, PP-145-149.