USE OF FLYASH FOR THE STABILIZATION OF SUBGRADE SOIL IN PAVEMENTS

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Abstract: The performance of pavements is very sensitive to the characteristics of the subgrade soil. For that reason, weak subgrade is augmented by espousing the most profitable stabilization technique. Based on the literature review, stabilization with fly ash activated subgrade found to be an effective option for improvement of soil properties. This study investigates the effect caused by the addition of fly ash on the geotechnical properties of subgrade soils. Different percentages of fly ash are added to the subgrade soil i.e., 12, 22, 32, and 42 per cent and the effect was studied. Tests were performed on consistency limits, compaction, California Bearing Ratio, and unconfined compression tests were conducted on untreated and flyash stabilized soils. The experimental results show that addition of fly ash admixture to the soil has great influence on its properties. It was found that the optimum dosage of fly ash is 22% revealed in significant improvement in strength and durability and reduction in swelling and plasticity properties of the soil. Based on the results, it is recommended that fly ash admixture be used for the stabilization of expansive subgrades.

Keywords : Subgrade Soil, Stabilization, Flyash, Compaction.

I. INTRODUCTION

The soil stabilization is the modification of soil properties to meliorate the engineering performance of soils. The properties most often modified are water content, density strength and plasticity. Modification of soil properties is the temporary enhancement of sub grade stability to expedite construction.

Fly ash can be a binder for stabilizing soils for highway bases. However, limited information resists on the recycle of high carbon fly ash in construction of highway pavements. This is particularly important when high carbon fly ash is calcium-rich and non-cementitious activators are required to generate pozzolanic reactions. Thus, there is a need to evaluate the stiffness and strength of base layers stabilized with high carbon fly ash. The subgrade soil must be compacted to an adequate density to provide the maximum structural support (as measured by MR, CBR or R-value). If it is not compacted then the subgrade will continue to deform or erode and compress after construction, causing pavement deformation and cracks. Generally, the density of soil is specified as a relative density for the top 150 mm (6 inches) of subgrade of not less than 95 Per cent of maximum density calculated in the laboratory. If the infill area is compacted to 90 per cent relative density then the subgrade below the top 150 mm (6 inches) is often considered adequate. In order to obtain these densities the subgrade must be at or near its optimum moisture content (the moisture content at which maximum density can be obtained). Usually compaction of fill subgrade or in situ will result in adequate structural support.

Fly ash is a substantive industrial by-product that comes from the combustion of coal. In our country, only a small percentage of fly ash is used for the construction of technical projects, while the rest is dumped (stockpiled), which causes severe problems to the accessible environment. It has been found that stabilization with fly ash increase the mechanical and engineering characteristics of soil, so it is a better option to use fly ash as a modifier. Stabilization of soils and pavement bases with coal fly ash is earning popularity among pavement engineers in the recent past.

II. MATERIAL AND METHODOLOGY

Mechanical stabilization is effected by mixing or blending soil of two or more gradations to find a material meeting the required specification. The soil blending may take place at the construction site, a central plant, or a borrow area. The blended material is then disperses and compacted to required densities by the conventional means (Gordon R. Sullivan, 1994).

Table 1: Geotechnical properties of unmodified soil

S. No	Property	Value
1	Gravel	1.5%

2	Sand	32.5%
3	Fines	66.3%
4	Bulk Density	2.3g/cc
5	Specific gravity	2.66
6	Liquid limit	35.8%
7	Plastic limit	22.3%
8	Plasticity index	13.5%
9	Optimum moisture content	10.6%
10	Maximum dry density	19.3kN/m^3

As there are numerous way to stabilize Natural soil because it is a complex and irregular material, Yet because of its broad presence all around the world and its low cost it offers great pass for skillful use as an engineering material. The various types of stabilization techniques are: Mechanical stabilization, Cement stabilization, Lime stabilization, Bitumen stabilization, Chemical stabilization, Thermal stabilization, Electrical stabilization, Stabilization by grouting, Stabilization By geotextiles and fabrics.

Table 2: Physical properties of fly ash

Colour	Dark gray
Specific gravity	2.74
Liquid limit	27%
Plastic limit	Non plastic
Maximum dry density	1.1g/cc
Optimum moisture content	32%
Swelling pressure	0.124kg/cm^2

Table 3: Chemical composition of fly ash

S. No.	**Chemical component**	**Chemical content by wt.%**	
		Class C	**Class F**
1	Silica(SiO_2)	40	55
2	Alumina(Al_2O_3)	16.5	26
3	Ferric Oxide(Fe_2O_3)	6.5	7
4	Calcium Oxide(CaO)	24	9
5	Magnesium Oxide(MgO)	2.3	2
6	Sulfate Oxide(SO_3)	3	1
7	Loss of Ignition(LOI)	6	6

The following table gives the standard loads adopted for different penetrations for the standard material with a C.B.R. value of 100%.

Table 4: Standard loads for different penetration value

Penetration of plunger (mm)	Standard load (kg)	Unit standard load, kg/cm^2
2.5	1370	70
5.0	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

- **Comparison of results of various samples (LL, PL, PI & SI)**

Table 5: Comparison of subgrade soil and stabilized subgrade soil(LL, PL, PI & SI)

S. No	Property	Subgrade Soil	88 % S.S + 12 % F.A	78 % S.S + 22 % F.A	68 % S.S + 32 % F.A	58 % S.S + 42 % F.A
1	Liquid limit (%)	36.4	34.1	32.2	33.1	36.1
2	Plastic limit (%)	22.9	25.1	24.3	25.6	27.8
3	Plasticity Index (%)	14.2	14.8	12.1	11.98	9.89
4	Shrinkage limit (%)	26.4	22.3	19.2	25.2	26.4

- **Comparison of results of various samples(MDD, OMC & UCS)**

Table 6: Comparison of subgrade soil and stabilized subgrade soil (MDD, OMC & UCS)

S. No	Property	Subgrade Soil	88 % S.S + 12 % F.A	78 % S.S + 22 % F.A	68 % S.S + 32 % F.A	58 % S.S + 42 % F.A
1	Maximum dry Density(KN/m^3)	20.1	18.3	18.4	18.2	17.3
2	O.M.C. (%)	11.1	14.12	14.34	14.75	16.1
3	U.C.S.(KN/m^2)	59.1	61.2	91.2	89.2	86.7

In the above table the values represents the increases or decreases over the unmodified subgrade soil property result. Analysis of test data in all the cases of subgrade soil + fly ash, the 78% S.S + 22% F.A. set gives optimized results than other as the value of UCS comes out to be Maximum In this case only and Also the Liquid Limit Is least in this case only. The Shrinkage Limit is also Low when the percentage of fly-ash is 22%. Three sets nearly 88% S.S + 12% F.A., 68% S.S. + 32% F.A & 58% S.S. + 42% F.A. set. By observing the above results when 78% S.S + 22% F.A. are kept constant the most optimum results are obtained as shown in table 10 and table 11.

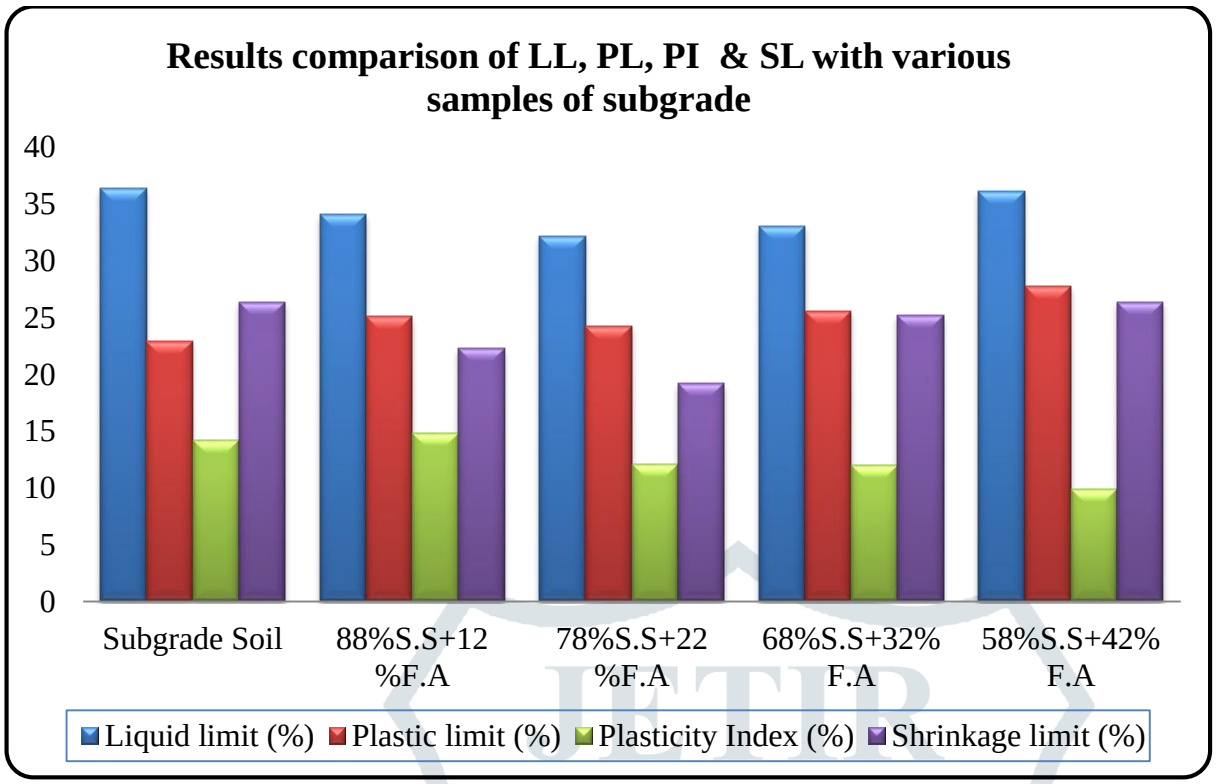

Fig. 1: Graphical comparison of subgrade soil to the stabilized subgrade soil (LL, PL, PI&SL)

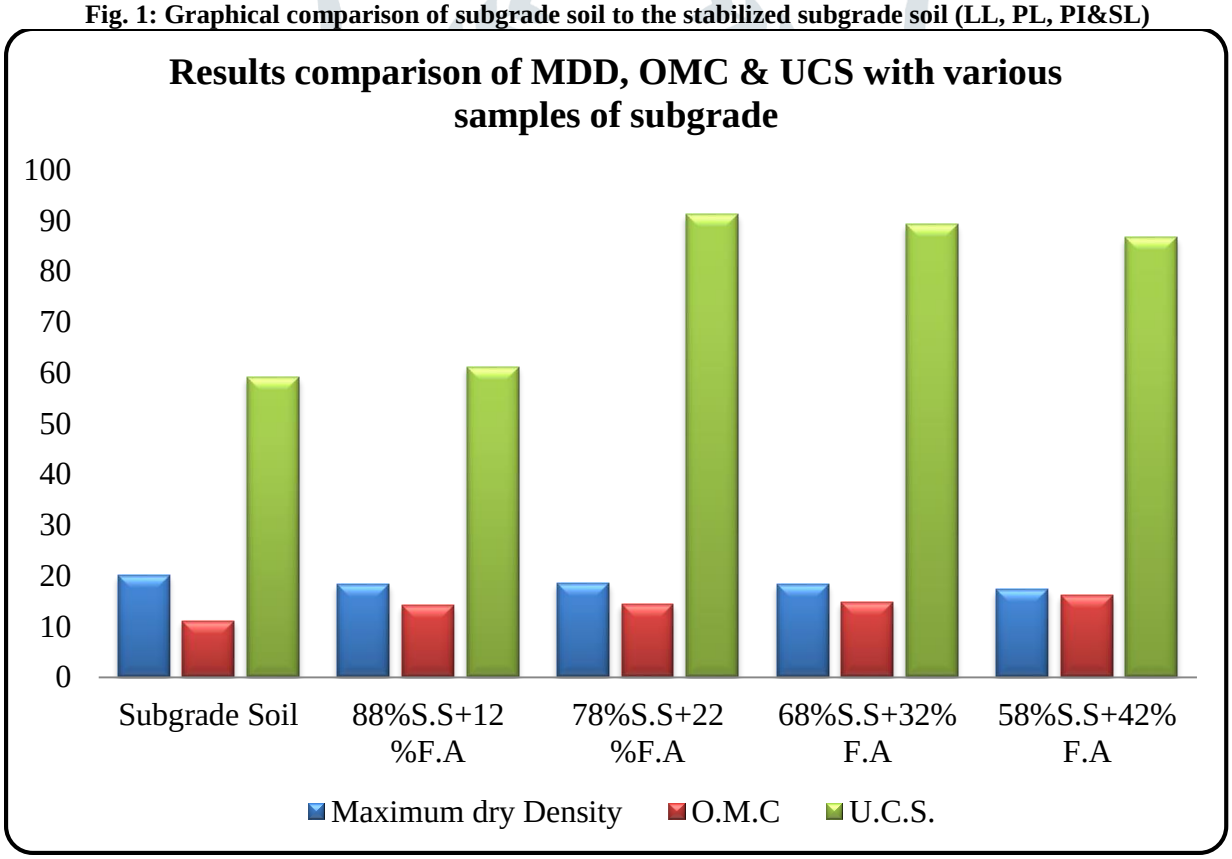

Fig. 2: Graphical comparison of subgrade soil to the stabilized subgrade soil(MDD, OMC & UCS)

III. CONCLUSION

- It was observed that OMC increases and MDD decreases with increased percentage of fly ash mixed with silty sand. The optimum value of fly ash mix was obtained to be approximately 22%.

- The variation of unconfined compressive strength (UCS) with percentage of fly ash mix expose that UCS increases up to 30% of fly ash mix and then it decreases.
- Through this experimentation it is observed that the by-product fly ash is also good stabilizing compound.
- The optimum proportions for the combination of subgrade soil + by product are 78% S.S + 22% F.A.
- When the percentage of fly ash increased then the liquid limit increased and plastic limit decreased
- With the addition of fly ash greater than 22%, the plasticity index of the soil is also decreased.
- With the addition of fly ash greater than 22%, the optimum moisture content of the soil is increased while the maximum dry density of soil decreased.
- With the addition of 22% of fly-ash, the unconfined compressive strength (UCS) of the stabilized subgrade soil is increased as compared to the subgrade soil.
- With the addition of 22% of fly-ash, the shrinkage limit of the stabilized subgrade soil is also reduced as compare to the subgrade soil.

IV. REFERENCES:

- Mowafy, Y.M., Baurer, G.R. and Sakeh, F.H, "Treatment of expansive soils: A laboratory study," Transportation Research Record, No. 1032, Transportation Research Board, 1985, 34-39.
- Petry, T.M. and Little, D.N, "Review of Stabilization of Clays and Expansive Soils in Pavement and Lightly Loaded Structures-History, Practice and Future," Journal of Materials in Civil Engineering, 2002, Vol. 14, No. 6.
- Budge, A.S. and Burdorf, M.J, "Subgrade Stabilization ME Properties Evaluation and Implementation," Final report, Center for Transportation Research and Innovation Minnesota State University, Mankato, 2012.
- Kowalski, T.E, Starry, D.W. and America, J. W, "Modern soil stabilization techniques," Annual conference of the Transportation Association of Canada, 2007, 1-16.
- ASTM. Annual Book of ASTM Standards. Section 4, Vol. 4.02, 4.08 and 4.09, West Conshohocken, 2003.
- Little, D.N., Males, E.H., Prusinski, J.R. and Stewart, B, "Cementitious Stabilization," 79th Millennium Rep. Series, Transportation Research Board, Washington, D. C, 2000.
- Scott, R.F. and Schoustra, J.J. Soil mechanics and engineering. McGraw Hill Book Company, New York, 1968.
- Venkatramaiah, C. Geotechnical engineering. New Age International Publishers, New Delhi, India, 2006.
- Consoli, N.C, Fappa, D, Festugato, L. and Deineck, K.S, "Key Parameters for Strength Control of Artificially Cemented Soils," Journal Geotechnical and Geo- environmental Eng., 133(2), 2007, 197-205.
- Davis, K.A., Warr, L.S., Burns, S.E. and Hoppe, E.J, "Physical and Chemical Behavior of Four Cement-Treated Aggregates," J. Materials in Civil Eng., 19 (10), 2006, 891-897.
- Ingles,O.G.andMetcalf,J.B.SoilStabilization:PrinciplesandPractice Butterworths, Sydney, 1972.