IJDI-ERET

INTERNATIONAL JOURNAL OF DARSHAN INSTITUTE ON ENGINEERING RESEARCH AND EMERGING TECHNOLOGIES
Vol. 1, No. 1, 2012
www.ijdieret.in

(Research Article)

Economic Evaluation of Flexible Pavement with respect to Fly ash and Lime Stabilization of Expansive sub-grade soil in Gujarat

Prof. R.R. Tank[1*], Prof. U.J. Solanki[2]

[1*,2]*Department of Civil Engineering, Darshan Institute of Engineering & Technology Rajkot, Gujarat, INDIA*

Abstract

This paper based on literature review on California Bearing Ratio behaviour of sub-grade soil with respect to stabilization agent added to evaluate economic cost with respect to pavement structure based on the sub-grade stabilization. In order to achieve the above mentioned objectives, it is required to study the geotechnical properties of the expansive soil and the effects of stabilizers i.e. by adding fly ash, lime and combination of both on the properties of expansive soil, especially CBR behaviour, solely based on the literature experiments has been studied and the comparative analysis is carried out between the stabilized and non-stabilized flexible pavement from the economic point of view. As per economic point of view the best option of stabilization is found that the Fly ash plus Lime, combination of two stabilizers are the best option for the expansive sub grade soil stabilization with optimum Lime : Fly ash - 4 : 2 % respectively, Lime stabilization is the second option for the expansive sub grade soil stabilization with optimum 6% of lime, Fly ash stabilization is the third option for the expansive sub grade soil stabilization with optimum 15% fly ash.

Keywords: CBR, Stabilization, lime, Fly ash, Sub-grade.

1. Introduction

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural expansive CH soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. Expansive soils, popularly known as black cotton soils in India, are problematic, as they swell on infiltration of water and shrink upon its evaporation. In dry condition, the soil possesses high strength. When saturated, it loses strength. In India, industries like thermal power plants and steel plants produce large quantities of waste material, whose disposal in open yards not only pollutes the atmosphere but also occupies precious land, which is scarce in this fast developing country. Therefore, its utilization, instead of disposal, is a better solution to solve the problem. Its use in the stabilization of expansive clay sub-grades in combination with lime is also very common.

[*]*Corresponding Author: e-mail: rrtank21@gmail.com, Tel-+91-99257-17185*
ISSN: 2320-7590

2. Need for Soil Stabilization

- Limited financial resources to provide a complete network road system to build in conventional method.
- Effective utilization of locally available in situ soils and other suitable stabilizing agents.
- Encouraging the use of industrial waste in construction of low cost roads.

3. Significance of Sub Grade Soil

Sub grade soil is an integral part of the road pavement structure as it provides the support to the pavement from beneath. The sub grade soil and its properties are important in the design of pavement structure. The main function of the sub grade is to give adequate support to the pavement and for this the sub grade should possess sufficient stability under adverse climate and loading conditions.

The formation of waves, corrugations, rutting and shoving in black top pavement and the phenomena of pumping, blowing and consequent cracking of cement concrete

pavements are generally attributed due to the poor sub grade conditions.

When soil is used in embankment construction, in addition to stability incompressibility is also important as differential settlement may cause failures. Compacted soil and stabilized soil are often used in sub-base or base course of highway pavements. The soil is therefore considered as one of the principal highway materials.

4. Stabilization

Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity or act as a binder for cementation of the soil. The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction; proportioning and or the addition of suitable admixture or stabilizers. Soil stabilization deals with physical physic-chemical and chemical methods to make the stabilized soil serve its purpose as pavement component material. The **basic principles** of soil stabilization may be stated as:

- Evaluating the properties of given soil.
- Deciding the method of supplementing the lacking property by the effective and economical method of stabilization.
- Designing the stabilized soil mix for intended stability and durability values.
- Considering the construction procedure by adequately compacting the stabilized layers.

Soil stabilization may result in any one or more of the following changes:

- Increase in stability, change in the properties like density or swelling change in physical characteristics.
- Change in chemical properties.
- Retaining and desired minimum strength by water proofing.

4.1 Additive Stabilization: Additive stabilization is achieved by the addition of proper percentages of lime, fly ash and cement or combinations of these materials to the soil. The selection of type and determination of the percentage of additive to be used is dependent upon the soil classification and the degree of improvement in soil quality desired. Generally, smaller amounts of additives are required when it is simply desired to modify soil properties such as gradation, workability and plasticity. When it is desired to improve the strength and durability significantly, larger quantities of additive are used. After the additive has been mixed with the soil, spreading and compaction are achieved by conventional means.

4.2 Additives: Manufactured commercial products that, when added to the soil in the proper quantities, improve some engineering characteristics of the soil such as strength, texture, workability and plasticity. An additive addressed in this paper is limited to lime, fly ash and combination of two.

Table 1. Physical properties of expansive soil

Properties	Values
Liquid limit(W_L) %	40 – 100
Plastic limit (W_P) %	20 – 60
Shrinkage limit (W_S) %	6 – 18
Free swell index (FSI) %	20 – 150
Unified soil classification	CH – MH
Bulk unit weight	13 – 18 kN/m^3
Natural water content (w) %	20 – 40
Standard proctor density	13 – 16 kN/m^3
OMC %	20 – 35
Swelling pressure	50 – 1000 kN/m^2
Clay content (%<2micron)	25 – 45
Compression index (C_C)	0.2 – 0.5
CBR (Soaked) %	1.2 – 4
Shear strength (C_u)	10 – 80 kN/m^2

Table 2. Chemical composition of flyash

Name of the chemical	Symbol	Range of % by weight
Silica	SiO_2	61 to 64.29
Alumina	Al_2O_3	21.60 to 27.04
Ferric oxide	Fe_2O_3	3.09 to 3.86
Titanium oxide	TiO_2	1.25 to 1.69
Manganese oxide	MnO	Up to 0.05
Calcium oxide	CaO	1.02 to 3.39
Magnesium oxide	MgO	0.5 to 1.58
Phosphorous	P	0.02 to 0.14
Sulphur trioxide	SO_3	Up to 0.07
Potassium oxide	K_2O	0.08 to 1.83
Sodium oxide	Na_2O	0.26 to 0.48
Loss on ignition		0.20 to 0.85

Lime, which is produced by heating limestone at elevated temperatures, is a product that is used often with highly plastic clays for sub grade improvement. In stabilizing the clay, lime performs two basic functions: flocculation and cementation. Flocculation reduces the plasticity index of a soil, thereby improving the workability and reducing the swell potential of the soil. The cementation process is a slow reaction after compaction, which increases the strength and durability of the soil. Cementation also creates a working

platform during construction and increases the durability of the soil. Cementation also creates a working platform during construction and increases the durability of the soil sub grade.

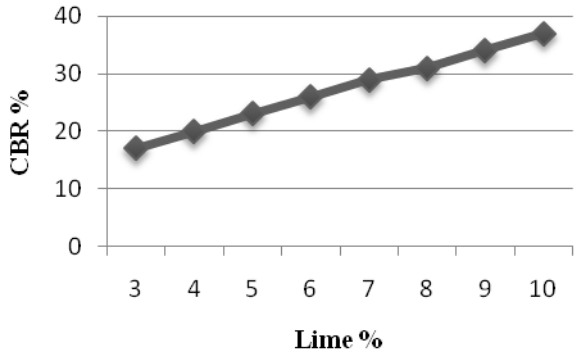

Figure 1. Relation between CBR and Lime

Above figure shows the relation between CBR and lime. As data shows California Bearing Ratio increases with Lime percentage also increases, so minimum lime content is 3% and maximum lime content is 10% and optimum lime content is 6%.

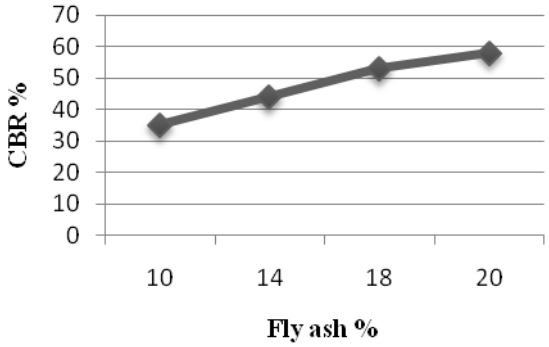

Figure 2. Relation between CBR and Fly ash

Above figure shows the relation between CBR and fly ash. As data shows California Bearing Ratio increases with fly ash percentage also increases, so minimum fly ash content is 10% and maximum lime content is 20% and optimum fly ash content is 15%.

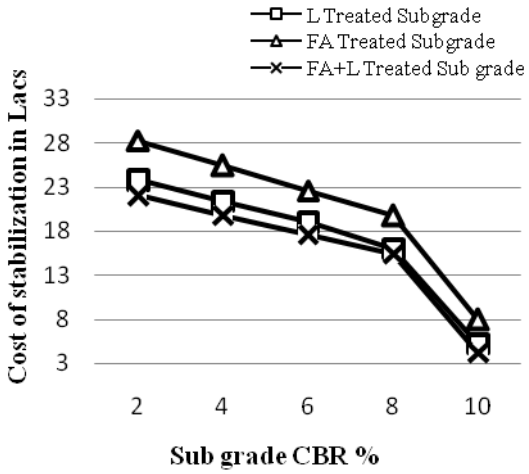

Figure 3. Relation between subgrade CBR vs. Cost of stabilization

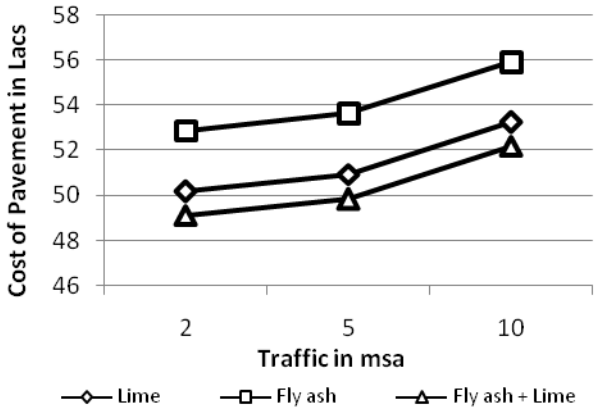

Figure 4. Relation between Traffic volume and Cost of pavement in Lacs

5. Conclusion

- The cost of sub grade soil stabilization for untreated is varied from 9 to 15 lacs, Lime treated is varied from 6 to 23 lacs, Fly ash treated is varied from 8 to 29 lacs and FA+L treated is varied from 5 to 22 lacs for varied CBR percentages.
- Lime treated sub grade soil stabilization CBR is 10% with cost of stabilization is around 6 lacs. And after stabilization of sub grade, pavement above layer cost is 50.17 lacs, 50.94 lacs and 53.24 lacs for varied traffic condition and pavement thickness.
- Fly ash treated sub grade soil stabilization CBR is 10% with cost of stabilization is around 8 lacs. And after stabilization of sub grade, pavement above layer cost is 52.87 lacs, 53.64 lacs and 55.94 lacs for varied traffic condition and pavement thickness.
- Fly ash plus Lime treated sub grade soil stabilization CBR is 10% with cost of stabilization is around 5 lacs. And after stabilization of sub grade, pavement above layer cost is 49.12 lacs,

49.84 lacs and 52.19 lacs for varied traffic condition and pavement thickness.

- From above figure data, we can say that the combination of Fly ash + Lime is the best option for the sub grade soil stabilization and second option is Lime of Fly ash stabilization.
- Here, effort is to raise the prevailing sub grade CBR to 10% desired CBR for sub grade soil.

6. References

1. Bhuvnshwari S.,“ Stabilization of expansive soils using fly ash”, Fly ash utilization programme, New Delhi,2005.