The 2016 World Congress on
Advances in Civil, Environmental, and Materials Research (ACEM16)
Jeju Island, Korea, August 28-September 1, 2016

Improvement in engineering properties of subgrade soil due to stabilization and its effect on pavement response

Prashant P.Nagrale[1)] and *Atulya P. Patil [2)]

[1)] Head of the Department, Civil Engineering, Sardar Patel College of Engineering, Mumbai, India

[2)] Ph.D. Student, Department of Civil Engineering, Sardar Patel College of Engineering, Mumbai, India
[2)] atulya.patil@yahoo.com

ABSTRACT

This paper presents laboratory investigation of stabilization of subgrade soil. One type of soil and three types of stabilizers i.e. hydrated lime, class F fly ash and polypropylene fibres are selected in the study. Atterberg limit, compaction, California bearing ratio (CBR), unconfined compressive strength and triaxial shear strength tests are conducted on unstabilized and stabilized soil for varying percentage of stabilizers to analyze the effect of stabilizers on the properties of soil. Vertical compressive strains at the top of unstabilized and stabilized subgrade soil were found out by elasto-plastic finite element analysis using commercial software ANSYS. Strategy for design of optimum pavement section was based on extension in service life (TBR) and reduction in layer thickness (LTR). Extension in service life of stabilized subgrade soil is 6.49, 4.37 and 3.26 times more due to lime, fly ash and fibre stabilization respectively. For a given service life of the pavement, there is considerable reduction in layer thicknesses due to stabilization. It helps in reduction in construction cost of pavement and saving in natural resources as well.
Key Words: California bearing ratio; stabilization; subgrade; layer thickness reduction; traffic benefit ratio

1. INTRODUCTION

Soil stabilization is one of the ground improvement techniques to improve certain properties of natural soils to meet the engineering purpose. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available stabilizers that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. The long term performance of any construction project depends on the soundness of the under lying soils. Unstable soils can create significant problems for pavements. Lack of adequate road network to cater to the increased demand and increased distress in road leading to frequent maintenance has always been big problem in India.

[1)] Professor
[2)] Ph.D Student
Note: Copied from the manuscript submitted to
"Geomechanics and Engineering, An International Journal" for the purpose of presentation at ACEM16.

Aggregate is generally expensive, Therefore it is important to minimize the aggregate layer thickness for a given service life This can be achieved by incorporating stabilization technique. This stabilization technique can increase the service life for a given aggregate layer thickness. Effective utilization of local weak soils by imparting additional strength using stabilization materials enable reduction in construction cost and improved performance for roads.

Exploring the feasibility of such materials for sub grade and embankment stabilization will help the road building sector to evolve a stronger, durable and economic design. A finite- element model of the pavement- layered structure provides the most modern technology and sophisticated characterization of materials that can be easily accommodated in the analysis. The primary objective of the present study is to evaluate the benefits in term of traffic benefit ratio (TBR) and layer thickness reduction (LTR) due to stabilization of subgrade soil.

2. EARLIER WORK

(Arbani and Viskarami 2007) observed that lime stabilization of geo-materials by producing cohesive materials in the soil increases the strength and decreases material plastic properties and hence these materials can be used for projects where high strength and high performance materials are desirable. The increase in strength of lime stabilized materials in compression as well as tension is attributed to the reactions between clay particles and lime. The clay lime compound provides the cemented material in soil. The optimum clay content to gain the maximum compressive strength and tensile strength of clayey sands is proposed to be between 25 to 30% for the investigated material. (Bagui 2012) reported that thickness of soil-cement base/ soil lime base reduce as modulus of soil- cement base / soil lime base increases for a particular number of repetition and CBR. When CBR increases from 3 to 5/7/10, the thickness of soil cement base/ soil lime base reduces significantly for any particular number of repetitions and CBR. (Moustafa et al. 2011) conducted a comparative study for optimization and quantification of the beneficial effects of stabilization of subgrade soils in flexible pavement system. Based on the investigated materials with the determined optimum amount of stabilizers, the service life of the simulated pavement section was increased by 67% to 231%. (Amu et al.2005) conducted the tests on expansive clay soil to determine the optimum quantity of lime and the optimal percentage of lime- Eggshell Powder combination and reported that lime stabilization at 7% is better than the combination of 4% ESP+ 3% lime.(Mishra and Rath 2011) studied the cost effectiveness of clayey soil & moorum, treated with fly-ash lime for construction of low volume roads and investigated that maximum saving was possible for 70% soil + 30% fly ash +2% lime. (Youssef et al.2012) carried out soil investigation with lime stabilization on high plasticity clay and reported that the shear strength of soil increased as lime concentration increased up to 4%. CBR was improved when the soil was treated with lime. (Nagrale and Srivastava 2009) concluded that dry density of soil decreases with lime content and C.B.R. value of soil increases from 1% to 2.74, 3.89 and 6.51% due to stabilization with 2.5, 5 and 7.5% lime content. There is considerable reduction in layer thicknesses and it is the function of percentage of lime and traffic for

Note: Copied from the manuscript submitted to
"Geomechanics and Engineering, An International Journal" for the purpose of presentation at ACEM16.