International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

Stabilization Option for Soil Subgrade in Low Volume Bituminous Pavements

Topuri. Maruthi & M.Srinivasareddy

1 Scholar, Department of civil, Nalanda Institute of Engineering and Technology, Village Kantepudi, Mandal Sattenapalli, District Guntur, Andhra Pradesh, India

2 Assistant Professor, Department of civil, Nalanda Institute of Engineering and Technology, Village Kantepudi, Mandal Sattenapalli, District Guntur, Andhra Pradesh, India

ABSTRACT

Poor sub grade soil conditions can lead to inadequate pavement support and reduce pavement life. Soils may be improved by soil stabilization by stabilizing by lime, fly ash, cement, rice husk, etc. which are generally waste products and they create disposal problems. These additives can be used with a variety of soils to help improve their engineering properties. The effectiveness of these additives depends on the soil treated and the amount of additive used. The sub grade strength is mostly expressed in terms of California Bearing Ratio (CBR). Weaker sub grade essentially requires thicker layers whereas stronger sub grade goes well with thinner pavement layers.

The pavement and the sub grade mutually must sustain the traffic volume. This work attempts to understand the strength of sub grade in terms of CBR values subjected to different types of stabilizers. Treatment with lime and fly ash was found to be an effective option for improvement of soil properties, based on the testing conducted as a part of this work. It was found that with the addition of stabilizers i.e. lime and fly ash, the C.B.R. increased up to a certain limit but after that the C.B.R. decreased even on the further addition of stabilizers. Long-term performance of pavement structures is significantly impacted by the stability of the underlying soils. In situ sub grades often do not provide the support required to achieve acceptable performance under traffic loading and environmental demands. Although stabilization is an effective alternative for improving soil properties, the engineering properties derived from stabilization vary widely due to heterogeneity in soil composition, differences in micro and macro structure among soils, heterogeneity of geologic deposits, and due to differences in physical and chemical interactions between the soil and candidate stabilizers. These variations necessitate the consideration of site -specific treatment options which must be validated through testing of soil -stabilizer mixtures. This report addresses soil treatment with the traditional calcium-based stabilizers: Portland cement, lime, and fly ash. The report describes and compares the basic reactions that occur between these stabilizers and soil and the mechanisms that result in stabilization. The report presents a straightforward methodology to determine which stabilizers should be considered as candidates for stabilization for a specific soil, pavement, and environment. The report then presents a protocol for each stabilizer through which the selection of the stabilizer is validated based on mixture testing and mixture design. The mixture design process defines an acceptable amount of stabilizer for the soil in question based on consistency testing, strength testing, and in some cases (resilient) modulus testing. Within each additive validation and mixture design protocol, an assessment of the potential for deleterious soil-additive reactions is made.

INTRODUCTION: In India, as part of infrastructure development, construction of pavements is taken up in a big way. While socio-economic factors govern the alignment, the in-situ ground conditions especially in black cotton soil govern the design and construction of the pavements and hence influence the project cost. Thus, there is constant need for cost effective ground improvement techniques. Roads form the part of the basic infrastructure for a nation and in a developing country like India where distances between two major cities can be a couple of thousand kilometers , roads can be actually termed as lifeline of the nation. Constructing roads for everyone need and maintaining the vast network, make considerable demand on construction material, India is a vast country where roads serve the purpose of connecting one region to another, one state to another and one metro to another. Road network system of India is important if we want to become an economic superpower. Today there is the need to create more roads, broaden the existing

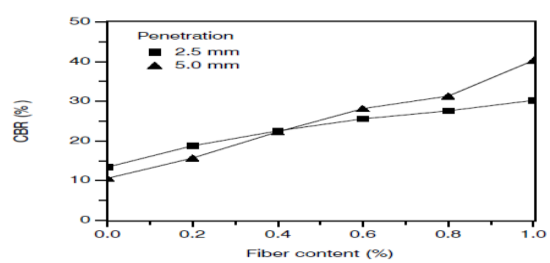
International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

ones and to make them safer so that India is on the road to become a developed nation. The development of transportation infrastructure is the key to overall development of the country. For countries like India, where resources are limited, the importance of rural/unpaved roads is to be highly emphasized. The sub grade, which is the bottom most layer of the pavement, is made up of compacted soil and so also for the highway and railway embankments. The concept of reinforced earth is based on the principle of Vidal, according to which, introduction of reinforcing elements in a soil mass increases the shear resistance of the medium. In applications of reinforced soil, there is constant debate on the effect of form of the reinforcement. Further, effectiveness of reinforcement function in submerged conditions is another point, which requires thorough investigations

SELECTION OF PROJECTS: Many roads are very good candidates for recycling. This road has many transverse,longitudinal, and reflected widening cracks. Many of these roads were widened in the past, and each time an overlay wasapplied, widening reflection cracks developed. Cold-mix re-cycling eliminates these cracks and provides a base with a uniform support across the entire width ofthe pavement. Roadshave also been built up over the years with open-graded cold mixtures or layer after layer of surface treatments. These roadsare also heavily patched. The base is ofa very non-uniform type,and if a hot-mix overlay is simply applied on these surfaces,extensive cracking will develop. These roads are also good candidates for simultaneous recycling and widening.Guidelines have been provided to the engineering districtsthat include information on the characteristics of cold recycledmixtures, the selection of projects, the estimation of quantitiesof materials, and construction. These guidelines aid the pavement management engineer in the development of cold recycling projects. Standard specifications have been developed for cold recycled, bituminous base courses. These specifications are versatile and permit the use of available or innovative recycling equipment and procedures. Information on these guidelines and specification Guntur , A.P. like many other states, is not currently buildingmany new highways. The existing highways are being maintained and upgraded as part ofthe so-called 3R Program: Restoration, Resurfacing, and Rehabilitation. Cold-mix recycling can play amajor role in upgrading the secondary low-volume roads. An attempt is being made to use cold-mix recycling on roads thatare far from the central mix plants. No standard designprocedure exists for designing these recycled mixtures, and much work needs to be done. In fact, no generally accepted, standard design procedure exists for the cold mixtures thatcontain 100 percent virgin aggregate. Therefore, an attempt isbeing made to work on the design and construction of coldrecycling projects at the same time, because cold recyclingappears to be an economical upgrading strategy. So far, about 90 cold-mix recycling projects have been completed.

LITERATURE REVIEW: A review of the literature revealed that various laboratory Investigations have been conducted on fiber-reinforced materials. The followings are the summaries of past experimental research on the behavior of reinforced sand and clay.



Investigates the resultant strength and ductility behavior when randomly distributed palm fibers are used to reinforce silty-sand soils. The composite soils were under examined for unconfined compression strength (UCS), CBR and compaction test. To investigate the behavior of the stress-strain relationship, stiffness, ultimate strength, residual strength and ductility of silty-sandy soils reinforced with palm fibers. CBR tests were carriedout to examine the effects of palm fiber on the ultimate strength of fiber-soil medium. Testing was conducted on specimens with fiber inclusion of

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

0.25%, 0.50%, 0.75%, 1.00% and 1.50%, for fiber lengths of 20mm and 40mm and for wet and saturated states. The CBR values are affected by both increases in fiber inclusion and fiber length. The average increase between saturated and wet specimens, for 20mm and 40mm fiber lengths, are 18% and 24.8% respectively. The increase in fiber length effectively increases the CBR, and this is more increases with increasing fiber inclusion. Saturating specimens decrease the CBR values considerably. With increase in palm fiber length, and fiber inclusion, the ductility increased and the stiffness decreased. The increase in fiber length effectively increased CBR values, and this trend was more effective when the fiber inclusion increased.

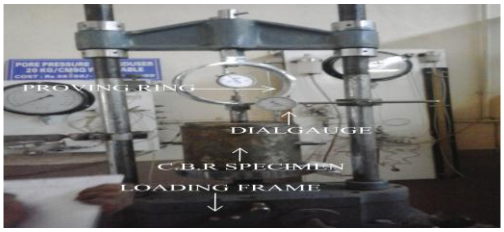
MATERIALS AND EXPERIMENTAL METHODOLOGY: The effectiveness of using reinforced soil for improving the CBR value has studied, CBR tests will conduct on samples reinforced with fibers and geo-textiles. This chapter provides in detail the physical and engineering properties of the materials used in the present work and also the testing procedure for performing the experiment investigations

Nonwoven geo-textiles are manufactured from high quality polypropylene staple fibers. The fibers are mechanically bonded through needle-punching to form a strong, flexible and dimensionally stable fabric structure with optimum pore sizes and high permeability. The geo-textile is resistant to chemicals and biological organisms normally found in soils and are stabilized against degradation due to short-term exposure to ultraviolet radiation. Nonwoven geo-textiles confirm to the following property values. The properties of Geo-textile and material are collected from M/s GMR infrastructure limited, Chennai are given in Table 3.4. Photographic view of the Nonwoven Geo-textile is shown in Fig.3.4.

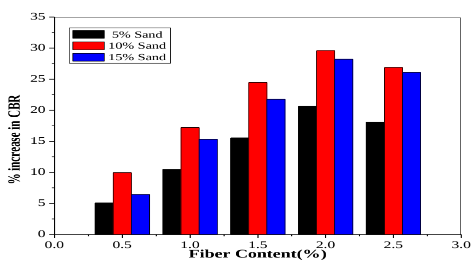
The Fig 3.7 shows photograph of California bearing ratio test setup. The methodology includes characterization of the materials used, the CBR values as per IS: 2720(Part- 16) - (1987) [28]. The mould containing the specimen, with the base plate in position shall be placed on the lower plate of the testing machine. Annular surcharge weight equal intensity of base material and the pavement is placed to prevent upheaval of soil.Penetration plunger is inserted in between the annular weight then adjusted to make contact with the specimen. Specimens were tested in a load frame, which gives the display of loads and penetrations. A standard plunger of 50mm diameter was penetrated into the soil at the rate of 0.625mm/minute. The load values corresponding to penetrations of 0.5mm, 1.0mm, 1.5mm, 2.0mm, 2.5mm, 3.0mm, 4.0mm, 5.0mm, 7.5mm, 10mm and 12.5mm were noted.CBR value is expressed as a percentage of the actual load causing the penetrations of 2.5 mm or 5.0 mm to the standard loads. The greatest value calculated for penetrations at 2.5mm and 5.0mm will be recorded as the CBR value. From the load - penetration graphs, CBR value was calculated as the highest value obtained from the ratio of test load divided by the standard load and expressed in percentage. The California bearing ratio is calculated as follows:

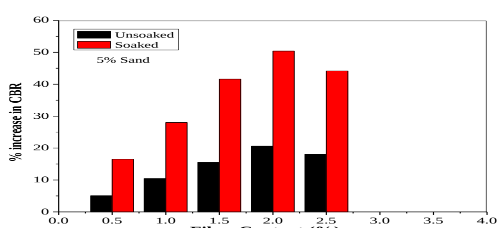
$$\text{CBR}(\%) = \frac{\text{Test Load}}{\text{Standard Load}} \times 100$$

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017



RESULTS AND DISCUSSION: Laboratory tests were conducted on black cotton soil with different 5%, 10% and 15% sand content. The CBR values were studied with 0.5, 1.0, 1.5, 2.0 and 2.5% polypropylene fiber content and nonwoven geo-textile with u/d ratio 0.6, 0.8 and 1.0. CBR values expressed in percentage for different cases are summarized, in which the initial CBR refers to percentage CBR obtained for soil alone without any reinforced material. The experimental results give a clear indication that the presence of fiber and nonwoven geo-textile influences the CBR of the soil. The improvement in strength of soil due to the addition of fiber and placement of geo-textile is a function of interaction of fiber and geo-textile with the sand. It was observed that there exists interaction between sands reinforced systematically with fiber and geo-textile in soaked and un-soaked condition





STEPS TO IMPROVE ROADS ON BLACK COTTON SOILS: Generally, lands with black cotton soils are fertile and very good for agriculture, horticulture, sericulture and aquaculture. Good irrigation systems exist, rainfall is high and people are affluent in these areas. Though black cotton soils are very good for agricultural purposes, they are not so good for laying durable roads. Good road network is a basic requirement for the all round development of an area. Unfortunately, poor road network is hampering the full fledged development of the otherwise prosperous areas. For developing a good and durable road network in black cotton soil areas, the nature of soils shall be properly understood. Black cotton soils absorb water heavily, swell, become soft and lose strength. Black cotton soils are easily compressible when wet and possesses a tendency to heave during wet condition. BC soils shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements. On such soils suitable construction practices and sophisticated methods of design are to be adopted. In the present paper, reasons for poor condition of roads in B.C soils and measures to be taken for construction and improvement of roads on BC soils arepresented.Following are some of the important reasons for poor condition of roads in BC soil terrain. Nature of BC soils

Figure. 1 Capillary Rise of Ground Water

Figure 2: Typical Cross Section of Road Showing the Required Pavement Composition as per IRC Guidelines

The importance of drainage arrangements is stressed in the Editorial of Indian Highways, October 2004 edition. Some excerpts are presented here under. Adequate arrangements to cater for both surface drainage and sub surface drainage are essential to prevent flooding of roads, weakening of road structure, formation of potholes, stripping of bitumen etc. The aim of good design should, therefore, be to remove the surface water efficiently and to keep water level well below pavement. Pavements are damaged more by water than from the effect of large volumes of traffic. The results of AASHTO road test have clearly indicated that the rate of serviceability loss of pavement where sub grade soil is saturated was 10 to 40 times higher as compared to those on dry sub grade soils

VALIDATION TECHNIQUES FOR STABILIZER SELECTION: LABORATORY TESTING METHODS: Stabilization projects are site specific and the soil-stabilizer interactions vary with soil types. Therefore the extent of improvement in soil properties is dependent on the interactions of the selected stabilizer with the soil. The following sections and sub-sections detail the techniques for validating the use of individual stabilizers and outline the requirements for selecting individual stabilizer type for field applications. The preliminary stabilizer selection process is outlined in Section .In the lime stabilization process, the extent of lime- soil interactions depends on the type and amount of clay minerals present in the soil. The mix design protocol given below is designed to optimize the potential for long-term strength gain and durability of lime stabilized soils. The candidate soil for lime treatment should be identified following the steps detailed in Section . Organic content in soil should be determined by following steps detailed in Section . If the organic content of the soil is above one percent, additionalcompression strength samples should be prepared and tested with higher lime contents, i.e., at least one to two percent above optimum lime content. The purpose of this testing is to determine whether the strength and durability of the lime-soil mixture can be enhanced with additional lime and that the additional lime compensates for the loss of free calcium due to adsorption of calcium by organic functionalities, which interuptcation exchange and pozzolainc reactions between calcium and the soils being treated. Water soluble sulfate levels in the soil to be treated with lime must be evaluated following steps detailed in Section 8.3.1. Soils with sulfate contents above 3,000 ppm may be considered problematic and should be addressed separately as detailed in the AASHTO Standard Recommended Practice for Stabilizing Sulfate Bearing Soils

REPORT

The report for stabilization of soils and base materials should include:

- ✓ Identification of sampling locations, details of locations of test pits and bore holes, and details of all other sampling sources used to obtain soil for test purposes.
- ✓ Details of subsurface conditions identified at the individual test pits, boring holes or by examining open cut sections during subsurface investigations.
- ✓ Approach used to select the stabilizer and method used to validate the selection of the stabilizer and perform mixture design.
- ✓ Tabulation of test data supporting the stabilization decisions.

CONCLUSIONS

- ➢ Laboratory test results for polypropylene fiber and nonwoven geo-textile with different sand content of 5% , 10% and 15% have been presented in chapter 4.Based on the investigations carriedout in this project work the following conclusions were made;
- ➢ The California bearing ratio (CBR) value can be improved phenomenally by reinforcing the material in both planar and in randomly distributed fiber forms.
- ➢ The CBR increases with the increase in sand content at an optimum fiber content of 2.0% and geo-textile at u/d =0.8.
- ➢ The improvement in CBR of randomly distributed fiber form has increased from 1.05% to 2.75% with a percentage increase of 55% in soaked condition and 2.99% to 4.77% with a percentage increase of 30% in unsoaked condition is achieved when 2.0% fiber content is used.
- ➢ For the materials used in this study, The maximum improvement in CBR of geo-textile has increased from 1.05% to 2.67% with a percentage increase of 50% in soaked condition and 2.99% to 4.37% with a percentage increase of 20% in unsoaked condition is achieved when the layer of geo-textile is placed at u/d=0.8.
- ➢ The investigations showed that, reinforcement effect is present even under soaked conditions.
- ➢ This paper developed an empirical low-volume road design guide, based on the USACE and the

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

NCSA pavement design methods. From a comparison among various low-volume road design approaches applied by several states in the US, these two design guides were found to be the least complex and require easily attainable input.

- The proposed guide is developed based on the same principles, that is, requires minimal input that is readily available to local agencies, and is simple to use. As inputs, approximations of the daily traffic and truck percentage are used, along with the sub grade soil type and strength. Given these factors and the location of the road (identifying weather characteristics affecting the pavement structure), specific aggregate and flexible road design options are given. The state of Indiana is presented as a case study and the specified low-volume road design options are presented. The flexibility of the proposed guide allows its use by most local agencies, and provides for the design of low-volume roads in a timely fashion.

- Future direction for work in low-volume road design should involve the development of a similar guide for tropical climates or cold regions, as the presented guide is anticipated to be well suited for regions characterized by moderate climate.

REFERENCES

[1] **Suresh.K, Padmavathi.V and Apsar Sultana**," Experimental Study on Stabilization of black Cotton soil with Stone Dust and Fibers", Indian Geotechnical Conference, 2009, pp 502-506.

[2] **Dixit.M.S and Pawar.S.H**," Study of Improvement in Properties of Soil by Addition of Polypropylene Fibers", Indian Geotechnical Conference, 2009, pp 182-184.

[3] **Kameshwar Rao, Anuj Kumar Sharma and Tarulata Meshram**," Laboratory Investigation of Use of Synthetic Fibers to Minimize swell in Expansive Sub grades", Indian Geotechnical Conference, 2009,pp 157-161.

[4] **Mahmood Abdi, Ali Parsapajouh and Mohammad Arjomand**," Effects of random Fiber Inclusion on Consolidation, Hydraulic Conductivity, Swelling, Shrinkage Limit and Dessication Cracking of Clays", International Journal of Civil Engineering, Vol. 6,2008, No. 4,pp 284-292.

[5] **Al-Refeai.T and Al-Suhaibani.A**," Dynamic and Static Characterization of Polypropylene Fiber-Reinforced Dune Sand", Geosynthetics International, Vol 5, 1998, No 5, pp 443-458.

[6] **Kumar.R, Kanaujia.V.K and Chandra.D**," Engineering Behavior of Fibre-Reinforced Pond Ash and Silty Sand", Geosynthetics International, Vol 6, 1999, No 6,pp 509-518.

[7] **Marandi.S.M, Bagheripour. M.H,Rahgozar. R and Zare.H**," Strength and Ductility of Randomly Distributed Palm Fibers Reinforced Silty Sand Soils", American Journal of Applied Sciences, 5(3), 2008,pp 209-220.

[8] **Choudhary.A.K, Jha.J.N and Gill.K.S**," A Study on CBR Behavior of Waste Plastic Strip Reinforced Soil", Emirates Journel for Engineering Research, 15(1), 2010, pp 51-57.

[9] **Amin.C, and Hamid.N**," CBR Test on Fiber Reinforced Silty Sand", International Journel of Structural and Civil Engineering, Vol 1, 2012,pp 1-9.

[10] **Naeini.S.A and Mirzakhanlari.M**," The Effect of Geo-textile and Grading on the Bearing Ratio of Granular Soils", Electronic Journal of Geotechnical Engineering, Vol 13, 2008, pp 1-10.

[11] **Nataraj.M.S and McManis.K.L**," Strength and Deformation Properties of Soils Reinforced with Fibrillated Fibers", Geosynthetics International, Vol 4, 1997, No 1,pp 65-79.

[12] **Dutta.R.K, Gayathri.V and Sarda.V.K**," A Study of the CBR Behavior of Low Density Polyethylene Waste Plastic Strip", Indian Geotechnical Society, 2009, pp 205-209.

[13] **Minu.M and Vinod.P**," California Bearing Ratio of Coir Geo-textile Reinforcement Sub grade", 10th National Conference on Technological Trends 6-7,2009,pp 63-67.

[14] **Naeini.S.A and Ziaie Moayed.R**," Effect of Plasticity Index and Reinforcement on the CBR Value of Soft Clay", International Journel

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

of Civil Engineering, Vol 7, 2009, No 2, pp 124-130.

[15] **Amin.C, and Hamid.N**," CBR Test on Fiber Reinforced Clay", Pan-Am CGS Geotechnical Conference, 2011, pp 1-4.

[16] **Bijayananda.M, MahipalSingh.C and Satyendra.M**," California Bearing Ratio of Randomly Oriented Fiber Reinforced Clayey Sub grade for Rural Roads", Proceedings of Indian Geotechnical Conference, (Paper No. J-354), 2011, pp 611-614.

[17] **SarikaDhule.B,Valunjkar.S.S, Sarkate.S.D and Korrane.S.S**," Improvement of Flexible Pavemennt with Use of Geo-grid", Electronic Journal of Geotechnical Engineering, Vol 16,2011,pp 269-279.

[18] **Senthilkumar.P and Pandiammal Devi.S**," Effect of Needle Punched Nonwoven Coir and Jute Geo-textiles on CBR Strength of Soft Sub grade", Journel of Engineering & Applied Sciences, Vol 6, 2011, No 11, pp 114-116.

[19] **Perdeep Singh and Gill.K.S**," CBR Improvement of Clayey Soil with Geo-grid Reinforcement", International Journel of Emerging Technlolgy and Advanced Engineering, Vol 2, 2012,Issue 6,pp 315-318.

[20] **Senthilkumar.P and Rajkumar.R**," Effect of Geo-textile on CBR Strength of Unpaved Road with Soft Sub grade", Electronic Journal of Geotechnical Engineering, Vol 17, 2012, pp 1355-1363.

[21] Ministry of Road Transport & Highways Specifications for Road and Bridge Works – 2001.

[22] Ministry of Rural Development Specifications for Rural Roads- 2004.

[23] Bhavanna Rao D.V (2005)," Adverse effects of using natural gravel in sub base, base and Water Bound Macadam." Indian Road Congress's Indian Highways –February (2005).

TOPURI.MARUTHI B-tech: QIS Institute of Technology, Ongole in 2015. M-tech: Highway Engineering (Decs) from NIET in 2017.

MARRI.SRINIVASA REDDY Asst. ProfessorB-tech from Nalanda Institute of Engineering & Technology. M-tech: Transportation Engineering from Nalanda Institute of Engineering & Technology (2014-2016)