SOIL STABILIZATION AND DURABILITY OF STABILIZED MATERIALS

RITU MEWADE

Govt. Polytechnic College Khirsadoh Chhindwara (MP)

Abstract –

Improvisation of the soil is done by the different technique to modify its engineering properties. It helps in improving the shear strength, stiffness modulus, water resistance and increases the load bearing capacity of the sub-grade soil which having the poor engineering properties. So, there is a need of new technique which is low in cost, eco-friendly and effective in improving the sub-base soil strength. Enzymes are the biological product which enhances the soil sub-grade strength by the catalytic reaction with the soil particles.

KEYWORDS:- Stabilization, Soil, Bio-Enzyme, Terrazyme, Cement Plastic bag Strips, Strength Characteristics, CBR Test, Cost Effective

I. INTRODUCTION

Soil may be defined as the natural loose surface material of the earth that supports plant growth when dug or ploughed. Clay is also a natural material composed mainly of fine grain materials that consist of tiny particles that have plastic and adhesive properties. Clay possesses small voids and pores which make it possible to retain water and water tend to cause the expansion and shrinkage, which could lead to settlement. When exposed to water in high quantity, clay tends to soften and liquefy and this property of clay makes construction difficult due to its low strength and stiffness. This has posed serious challenges in geotechnical engineering because weak soil may cause damage to the foundation of buildings and cause cracks to buildings and along road pavement. Soil stabilization may be defined as the alteration or preservation of one or more soil properties to improve the engineering characteristics and performance of the soil. Soil stabilization generally refers to the procedure in which a special soil, cementing material, or other chemical materials are added to a natural soil to improve one or more of its properties. Stabilization therefore looks at the various methods employed for modifying the properties of a soil to improve its engineering performance. One may achieve soil stabilization through mechanically mixing the natural soil and stabilizing material together so as to achieve a homogeneous mix or by adding stabilizing material to undisturbed soil deposit and obtaining interaction by letting it permeate through soil voids. When soil is stabilized by use of additives it improves the properties of less-desirable road soils. When used these stabilizing agents can improve and maintain soil moisture content, increase soil particle cohesion and serve as cementing and water proofing agents [1].

Road Infrastructure plays a significance role in the country's economy by providing efficient and cheapest transport facilities in both developed and developing countries. Pavement is the one of primary element and important component in the road infrastructure, which provides firm surface for smooth, safe and efficient movement of vehicular traffic. Subgrade is the integral part of the pavement system, which plays a major role in providing sound durable surface. Subgrade is defined as a compacted layer naturally occurring local soil or stabilized soil from borrow pits just beneath the pavement crust, providing a suitable foundation for the pavement structure. Subgrade layer should be well compacted at all situations to utilize its full strength to economize on the overall pavement thickness. Subgrade layer play an important role in imparting structural stability to the pavement structure as it receives dynamic transient loads imposed upon it by vehicular traffic. These Traffic loads need to be transmitted in a systematic manner in such a way that the subgrade deformation is to be within the elastic limits, and the shear forces developed are to be within the safe limits under adverse climatic and traffic loading conditions. In case of highways less CBR value soils require higher pavement thickness of design traffic, resulting in costly pavement composition. To overcome this problem associated with soil, many techniques have been developed by different researches in terms of subgrade stabilization [2].

II. SOIL STABILIZATION

Stabilization of soil in a broader sense is the modification of the properties of a soil is improving its engineering performance. Soil stabilization is broadly used about road, pavement and foundation construction. It improves the engineering properties of the soil in terms of volume stability, strength and durability. In case of road construction, the aim of stabilization of soil to increase the stability by increasing its bearing capacity and hence increasing its strength and reduction in pavement thickness. Soil stabilization improves the strength of the soil, thus, increasing the soil bearing capacity, used to decrease permeability and compressibility of the soil mass in the earth structure, more economical both in terms of cost and energy to increase the bearing capacity of soil, improves workability and durability of the soil and maximize the lifecycle costs of projects [3].

III. BASIC PRINCIPLES OF SOIL STABILIZATION

Different methods of soil stabilization are controlled by different factors and variables, as such an all governing principle cannot easily be described which encompasses all the methods of soil stabilization. However, it is generally accepted that before any method of soil stabilization is used irrespective of which certain factors should be considered such as [4]:

1. Evaluate the properties of the given soil type – As earlier stated, the first and foremost criteria for the stabilization of any soil is its composition. The engineering properties possessed by a given soil depend largely on the composition of the soil. By understanding and evaluating the composition of the given soil, and in so doing, its engineering properties, the appropriate method to be employed in the stabilization of the soil can be identified [5].

2. Decide the most suitable, effective and economical method of soil stabilization for supplementing the lacking properties – Due to differing engineering properties, the stabilization method used for clay soils may not be suitable when employed for sandy soil. In the event that it is, which is highly unlikely, it may not be economical in both situations. As such, proper thoughts and considerations need to be put in place in deciding the most appropriate method or methods to be utilized in the stabilization process [6].

3. Design the soil mix with stability and durability values.

4. Considering the construction procedure by adequately compacting the stabilized layers [7].

IV. NEED FOR SOIL STABILIZATION

- Limited Financial Resources to Provide a complete network Road System to build in conventional method
- To improve certain undesirable properties of soils e.g. excessive swelling and shrinkage, high plasticity, difficulty in compaction etc.
- Effective utilization of locally available soils and other suitable stabilizing agents.
- Encouraging the use of Industrial Wastages in building low cost construction of roads.

V. CLASSIFICATION OF SOIL STABILIZATION

With respect to the addition of certain additives, soil stabilization process may be roughly grouped into two:

1. Stabilization of existing soil without any additives.

2. Stabilization of existing soil with the use of additives – Mechanical stabilization is a perfect example of the second which improve the inherent shear strength of the existing soil alongside other examples like cement stabilization, lime stabilization, bitumen stabilization etc. while for the first compaction and drainage are good examples [8].

VI. TYPES OF ADDITIVES

The types of additives include cementing agents, modifiers, water proofing agents, water retaining agents, water retarding agents and several miscellaneous chemicals. The behavior of each of these additives is different than that of the others and as such, possesses certain suitable or particular use and limitations. In the case of cementing agents, Portland cement, lime, lime-pozzolana and sodium silicate are some examples. Portland cement has been used extensively in many states in the improvement of existing graved road as well as in stabilizing the natural sub-grade soils. Hydrated lime can also play the role of cementing agent through a chemical reaction between the free lime and the silica alumina content contained in the soil. Hydrated lime is best suitable in granular materials and lean clays than in expansive or fat clays. The quantity required for a proper hydration is generally relatively low. One major down side to the use of cementing materials in soil stabilization is its cost which results in low or small quantities of the material being added to the soil which merely modifies it rather than undergo actual cementing action. Modifiers which are often used are also Portland cement, lime and bitumen. Relatively small quantities of cement and lime will change the water film on the soil particles, modify the clay minerals to some extent and will decrease the plasticity index of the given soil [9].

Factors to be Considered In the selection of a stabilizer, the factors that must be considered are the type of soil to be stabilized, the purpose for which the stabilized layer is used, the soil improvement desired, the required strength and durability of the stabilized layer and the cost and environmental conditions. The following parameters are required to be considered while selecting the type of stabilizer [10].

a) Soil types and additives:

There may be more than one candidate stabilizer applicable for particular soil type. However, there are some general guidelines that make specific stabilizers more effective based on soil granularity, plasticity, or texture. Portland cement for example can be used with a variety of soil types; however, since it is imperative that the cement be mixed intimately with the fines fraction (less than 0.075 mm size), the more plastic materials should be avoided. Generally, well-graded granular materials that possess sufficient fines to produce a floating aggregate matrix (homogenous mixture) are best suited for cement stabilization. Lime will react with soils of medium to high plasticity to produce decreased plasticity, increased workability, reduced swell and increased strength. Lime is used to stabilize a variety of materials including weak subgrade soils, transforming them into a "working table" or sub-base; and with marginal granular base materials, i.e., clay-gravels, "dirty" gravels, to form a strong, high quality base course. Fly ash is a pozzolanic material, i.e. it reacts with lime in powdered form in presence of water and is, therefore, almost always used in combination with lime in soils that have little or no plastic fines. It has often been found desirable to use a small amount of Portland cement with lime and fly ash for added strength. This combination of Lime-Cement-Fly Ash (LCF) has been used successfully in sub-base course stabilization [11-15].

b) General Guidelines:

The following are general guidelines when considering stabilization with different additives.

VII. DURABILITY OF STABILIZED MATERIALS

The failure of stabilized materials by disintegration into a loose mass is not common. It is most likely to be due to deficiency either in the amount of stabilizer, deficiency in the quality of the stabilizer, or deficient compaction or curing. These problems should not occur if a good standard of preliminary testing for suitability and of quality control are maintained. It is reported that the most common type of failure of stabilized layers is the peeling-off of surface dressings from stabilized layers. This is usually due to failure of top of the layers itself rather than any of the shortcoming of the surface dressing. The surface of the layer tends to disintegrate under traffic, the most likely cause of which is considered to be as a result of overstressing of the surface layer during the compaction of the stabilized material at the time of construction. This induces a series of shallow shear planes in the surface layer and result in a sharp falling-off density of the material towards the upper surface. Overstressing is most prevalent with uniformly graded non-cohesive sands. It can be avoided if special care is taken with the compaction and if towed vibrating rollers are used. A survey of known causes of lack of durability of stabilized layers confirmed that the most common problem was surface disintegration of the primed layer during construction and scabbing of the seal in service due to an inadequate bond with the stabilized material. These problems are a result of inadequate compaction and curing and are more likely to occur in hot, dry climates. Apart from the problem of surface disintegration, long-term durability may also be impaired by the effects of sulphates and by carbonation.

Some stabilization techniques are listed belowa Mechanical Stabilization b Stabilization by using different types admixers

(1) Lime Stabilization

(2) Cement Stabilization

(3) Chemical Stabilization

(4) Fly ash Stabilization

(5) Rice Husk ash Stabilization

(6) Bituminous Stabilization

(7) Thermal Stabilization

(8) Electrical Stabilization

(9) Stabilization by Geo-textile and Fabrics

(10) Recycled and Waste Products etc.

a Mechanical Stabilization

Mechanical Stabilization is the process of improving the properties of the soil by changing its gradation. This process includes soil compaction and densification by application of mechanical energy using various sorts of rollers, rammers, vibration techniques and sometime blasting. The stability of the soil in this method relies on the inherent properties of the soil material. Two or more types of natural soils are mixed to obtain a composite material which is superior to any of its components. Mechanical stabilization is accomplished by mixing or blending soils of two or more gradations to obtain a material meeting the required specification.

b Stabilization by using different types admixers

VIII. CONCLUSIONS

As technology advances and economic conditions change, many more chemical agents will be introduced into subgrades to improve their compactability, durability, and strength. At the same time, more performance-based testing will be necessary to prove the effectiveness of these stabilization agents. In addition, there are chemicals being used today in the petrochemical industry whose use in soils is as yet unexplored. Another area for research is such processes as injection and spray-on techniques for more economical treatment. Global climate change may affect the durability and application of stabilizers. It may be desirable to consider these potential changes in the development of future soil stabilization techniques [7].

REFERENCES

[1] Perloff. W. H. (1976), "Soil Mechanics, Principals and Application", New York: John Wily, & Sons.

[2] Janathan Q. Addo, Sanders, T. G. & Chenard, M. (2004), Road dust suppression: "Effect on unpaved Road Stabilization".

[3] Chen, F. H. (1981), "Foundation on Expansive soil", Amsterdam: Elsevier Scientific Publishing Company.

[4] DAMAGE TO FOUNDATIONS FROM EXPANSIVE SOILS, J. David Rogers, Robert Olshansky, and Robert B. Rogers.

[5] Sherwood, P. (1993). Soil stabilization with cement and lime. State of the Art Review. London: Transport Research Laboratory, HMSO.

[6] Pousette, K., Mácsik, J. and Jacobsson, A. (1999). Peat Soil Samples Stabilized in Laboratory-Experiences from Manufacturing and Testing. Proceeding of Dry Mix Methods for Deep Stabilization (pp. 85-92). Stockholm: Balkema, Rotterdam.

[7] Cortellazzo, G. and Cola, S. (1999). Geotechnical Characteristics of Two Italian Peats Stabilized with Binders. Proceeding of Dry Mix Methods for Deep Soil Stabilization (pp. 93-100). Stockholm: Balkerma.

[8] Al-Tabbaa, A. and Evans, W. C. (2005). Stabilization-Solidification Treatment and Remediation: Part I: Binders and Technologies-Basic Principal. Proceedings of the International Conference on Stabilization/Solidification Treatment and Remediation (pp. 367-385). Cambridge, UK: Balkerma.

[9] Hebib, S. and Farrell, E. R. (1999). Some Experi ences of Stabilizing Irish Organic Soils. Proceeding of Dry Mix Methods for Deep Soil Stabilization (pp. 81-84). Stockholm: Balkema.

[10] FM5-410, (2012). Soil Stabilization for Road and Airfield. www.itc.nl/~rossiter/Docs/FM5-410.

[11] Lambe, T. W. (1958). The structure of compacted clay. Journal of Soil Mechanics and Foundation. 84, 55-70.

[12] Keller Inc., (2011). Improvement of Weak Soils by the Deep Soil Mixing Method. Keller Bronchure, 32-01E:http://keller-foundations.co.uk/technique/deep-dry-soi lmixing.

[13] White, D. (2005). Fly Ash Soil Stabilization for Non-Uniform Subgrade Soils. IHRB Project TR-461, FHWA Project 4.

[14] Rogers, C. D. F. and Glendinning, S. (1993). Modification of clay soils using lime. In C. a. Rogers (Ed.), Proceeding of the Seminar held at Loughborough University on Lime Stabilization (pp. 99-114). London: Thomas Telford.

[15] EuroSoilStab. (2002). Development of Design and Construction Methods to Stabilize Soft Organic Soils: Design Guide for soft soil stabilization. CT97-0351, European Commission, Industrial and Materials Technologies Programme (Rite-EuRam III) Bryssel.