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Soil Stabilizers For Soil Stabilization: A Review

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Abstract :*The soil available on above ground surface and below the ground at various regions in the country often is weak and has no enough stability to carry structure load. The aim of the study was to review on stabilization of soil using various kinds of stabilizer. Several stabilizers are available to stabilize the expansive soils. So many stabilizers using low cost techniques, traditional soil stabilizers, soil reinforcement. All these have the disadvantages of being ineffective and expensive. Based on literature, bio-enzyme, fujibutton effective to soil stabilization.*

This is a review paper on soil stabilizers focusing on different type of traditional and non-traditional additive used in soil stabilization. Use of non-traditional additive such as tire, jute, fibers etc. not only improves soil properties but also solves the problem of waste disposal.

Index Terms* -Bio Enzyme, Traditional Soil Stabilizer. Non-traditional Soil Stabilizer,*Geopolymerization.

1.Introduction

The idea of using any kind of stabilizer for soil stabilization to improve the bearing capacity of concerned soil was developed from the application of stabilizer products used to treat soil in order to improve horticultural applications. A modification to the process produced a material, which was suitable for stabilization of poor ground for road traffic. When added to a soil, the stabilizers increased the wetting and bonding capacity of the soil particles.

Some harmless, effective and economical stabilizers introduced here for stabilizing the weak soil.

In recent era country population has increased significantly, available resources are reduces day by day and incapable of fulfilling the demand caused by the growth in population. Researchers are trying to create new technologies and methods to improve the techniques that are being used to utilize the resources. Thus it becomes necessary to employ such techniques to make the best use of resources. Civil engineering aspect of proper utilization includes land stabilization through which we can modify land with inferior engineering properties into land which has adequate engineering properties. Stabilization in broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance, which can be done by various methods of soil stabilization. Mechanical stabilization includes hauling, filling and compacting of soil, grade improvement and compaction while chemical stabilization includes mixing of admixtures to improve soil properties.

Soil Stabilization:

Pavement design is based on under laying earth strata that minimum specified structural quality will be achieved for each layer of material in the pavement system. The subgrade soil strata must resist vehicle load, avoid excessive deflections that responsible for fatigue cracking within the layer or in overlying layers, and resist excessive permanent deformation through densification. As the prpperty of a soil layer is increased, the ability of that layer to distribute the load over a greater area is generally increased so that a reduction in the required thickness of the soil and surface layers may be permitted. The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. In wet weather, stabilization may also be used to provide a working platform for construction operations.

Different procedures of soil stabilisation:

Soil stabilisation is a procedure where natural or synthesized additives are used to improve the properties of soils. Several stabilisers available for stabilizing problematic soils. Therefore, the techniques of soil stabilisation can be classified into a number of categories with different points of view. Some of the methods appeared in Fig. 1 may have the disadvantages of being ineffective and/or expensive (Amin EsmaeilRamaji*et al.*, 2014

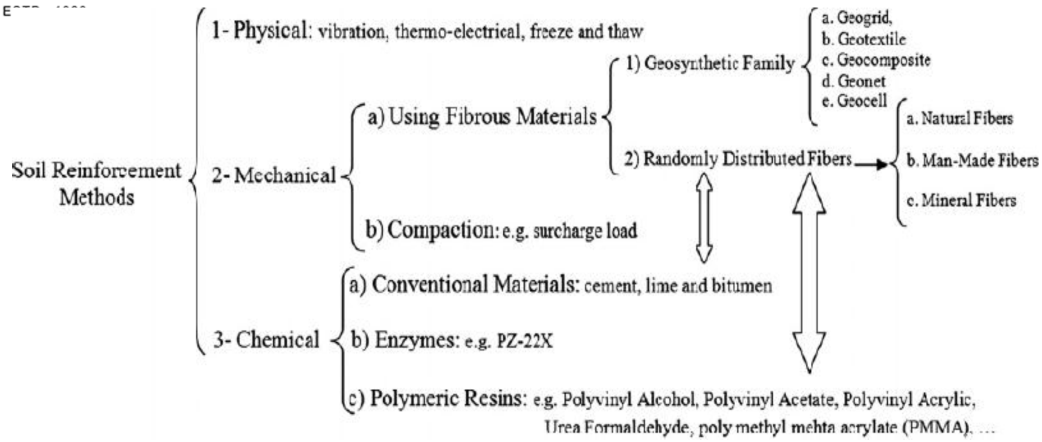

Fig. 1: Different procedures of soil reinforcement (Hejazi*et al.*, 2012).

Stabilization with Portland cement:

Portland cement can be used either to modify and improve the quality of the soil or to transform the soil into a cemented mass with increased strength and durability. The amount of cement used will depend upon whether the soil is to be modified or stabilized (Joint Departments of the Army and Air Force, 1994). Portland cement is hydraulic cement made by heating a limestone and clay mixture in a kiln and pulverizing the resulting material (Kowalski et al., 2007).

Stabilization with lime:

In general, all lime treated fine-grained soils exhibit decreased plasticity, improved workability and reduced volume change characteristics. However, not all soils exhibit improved strength characteristics. It should be emphasized that the properties of soil lime mixtures are dependent on many variables. Soil type, lime type, lime percentage and curing conditions (time, temperature, and moisture) are the most important (Joint Departments of the Army and Air Force, 1994). Lime is a white or grayish-white, odorless, lumpy, very slightly watersoluble solid, CaO, that when combined with water forms calcium hydroxide (slaked lime). Calcium hydroxide is used chiefly in mortars, plasters, and cements (Kowalski et al., 2007).

Stabilization with fly ash:

Fly ash is fine particulate ash created by the combustion of a solid fuel, such as coal, and discharged as an air born emission, or recovered as a byproduct for various commercial uses. Fly ash is used chiefly as a reinforcing agent in the manufacture of bricks, concrete, et cetera. There are two major classes of fly ash, C and F. Class F is produced from burning anthracite or bituminous coal; it usually has cementitious properties in addition to pozzolanic properties. Class C is produced by burning sub-bituminous coal and lignite, and is rarely cemetitious when mixed with water alone. White (2005) reported:

- Iowa self-cementing fly ashes are effective at stabilizing fine-grained Iowa soils for earthwork and paving operations.
- Fly ash increases compacted dry density and reduces the optimum moisture content.
- Strength gain in soil-fly ash mixtures depends on cure time and temperature, compaction energy, and compaction delay.
- Rapid strength gain of soil-fly ash mixtures occurs during the first 7 to 28 days of curing, and a less pronounced increase continues with time due to long-term pozzolanic reactions.
- Fly ash effectively dries wet soils and provides an initial rapid strength gain, which is useful during construction in wet, unstable ground conditions. Fly ash also decreases swell potential of expansive soils byreplacing some of the volume previously held by expansive clay minerals and by cementing the soil particlestogether.
- Soil-fly ash mixtures cured below freezing temperatures and then soaked in water are highly susceptible toslaking and strength loss. Compressive strength increases as fly ash content and curing temperature increase.
- Soil stabilized with fly ash exhibits increased freeze-thaw durability.
- Soil strength can be increased with the addition of hydrated fly ash and conditioned fly ash, but at higherrates and not as effective as self-cementing fly ash.
- CaO, Al2O3, SO3, and Na2O influence set time characteristics of self-cementing fly ash.

Scrap Tire:

Tire wastes can be used as lightweight material either in the form of whole tires, shredded or chips, or in mix with soil. Many studies regarding the use of scrap tires in geotechnical applications have been done especially as embankment materials (Ghani*et al.*, 2002). Tires have been reused in many different applications mainly related to production of new rubber based materials. Another major form of tire recycling is burning tires for fuel at tire derived fuel (TDF) facilities. There have also been reports that describe construction related applications for waste tires such as crumb rubber modifiers for highway pavement and shredded tires as fill material. The reuse application for tires is dependent on how the tires are processed. Processing basically includes shredding, removing of metal reinforcing, and further shredding until the desired material is achieved (Carreon, 2006).

Fig. 2: Scrap tire rubber.

2. Review Of Soil Stabilization Using Traditional And Non-Traditional Stabilizers.

2.1 Crumb Rubber With Soil

Shiva Prasad and P.T. Ravichandran had been check the effect of crumb rubber on the behaviour of soil they used two different soils and conducted proctor test and unconfined compressive strength test to analyse the MDD and strength values of soil.

They used crumb rubber in the range 425 micron to 600micron and prepared a soil rubber mix of varying crumb rubber percentage (5%, 10%, 15%, and 20 % by weight) results obtained from proctor test shows decrease in MDD and OMC with the increase in crumb rubber percentage this was happened due to light weight nature of rubber.

UCS test showed increase in strength values with increased rubber percentage up to 15% .the percentage improvement in UCS values was 45% for soil S1 up to 10% crumb rubber and 80% for soil S2 up to 15% crumb rubber.

2.2. Soil Stabilization WithFlyash And Rice Husk Ash

Er. Jasvir Singh and Er.Harpreet Singh Maan studied the effect of fly ash and rise husk ash on the behaviour of locally available clayey soil and evaluate the CBR by using optimum content of fly ash and rise husk ash respectively and also evaluate the UCS by using optimum content of fly ash. They used ranging of FA and RHA from 8% to 24% by wt. of soil (replacing) and found following results

1 .Soil with varying percentage of fly ash gives maximum CBR value at 8% fly ash. It increases from 3.94 % to 6.8 %. With further addition of fly ash, it keeps decreasing.

2 .Unconfined compressive strength of soil with 8% fly ash increased as compared to virgin soil from 2.154 kg/cm2 to 2.38 kg/cm2. It was maximum as 4.80kg/cm2 when 24 % Paper mill sludge ash was added. After there was decrement in UCS when 26 % paper mill sludge ash was added.

3. The soil with 8 % fly ash was further blended with variable percentage of rice husk ash (4%,8%, 12%,16%&20%). The major improvement in CBR occurred at 8% fly ash mixed with 12% rice husk ash and thereafter, further addition of rice husk ash is causing gradual change in CBR values. The peak soaked CBR value is 8.9 %.

2.3. Stabilisation Of Pavement Subgrade Soil Using Cement

G.R. Shiromanistudied the effect of cement on the behaviour of subgrade soil and his study made a comprehensive examination of the effectiveness of cement treatment on geotechnical properties of soils taken from ABU PUR, Modinagar U.P.

1. Test result indicate that with the increase in cement content liquid limit, plastic limit and plasticity index decreases as compared to untreated sample.

2. Maximum dry density increases while optimum moisture content reduced with increasing 2%, 4%, and 6% cement with respect to untreated soil sample.

3. Test result of direct shear test indicates with increase in cement content the value of cohesion „c" decreases and the value of angle of internal friction „Φ" increases with every interval of increment of cement.

4. California bearing ratio (CBR) of stabilized samples increases sharply with increases cement content. CBR of sample stabilized with 6% cement and compacted of 5 layers with heavy energy of 55 blown in each layers fulfil the criteria proposed by AASHTO soil classification.

2.4. Soil Stabilization Using Lime

Ankit Singh Negi , Mohammed Faizan , DevashishPandeySiddharth and Rehanjotsingh had check the lime effect on behaviour of silt or clay soil and summarised the following results.
1.Lime is used as an excellent soil stabilizing materials for highly active soils which undergo through frequent expansion and shrinkage.
2. Lime acts immediately and improves various property of soil such as carrying capacity of soil, resistance to shrinkage during moist conditions, reduction in plasticity index, increase in CBR value and subsequent increase in the compression resistance with the increase in time.
3. The reaction is very quick and stabilization of soil starts within few hours.
4.The graphs presented above give a clear idea about the improvement in the properties of soil after adding lime.

2.5. Soil Stabilization Using Bio-Enzyme (Terrazyme)

Mr.ShirsathH.A. ,Mr.Joshi S.R. ,Dr.Sharma V.J. found the following results of Terrazyme stabilizer on engineering properties of soil for 100ml/1.5m3, 200ml/1.5m3 and 300ml/1.5m3 of soil.
1.TerraZyme stabilization has shown good modification in index andengineering properties of all three soil (two black cotton soil and one red soil).
2.Unconfined Compressive Strength of all three soil has increased with increase of curing time with TerraZyme.
3.The properties of all soil have been much improved by stabilizing with TerraZyme dosage of 200ml/1.5m3 of soil. Hence this dosage is considered as the optimum one.
4.Compaction characteristics (MDD) are not affected immediately after treatment with TerraZyme.
5.Free Swell Index of black cotton soil from sangamner and red soil from surgana reduced with treatment from TerraZyme dosage no 2especially with drying.
6. Terrazyme is found to be ineffective for improving consistency limits.
7.The initial cost of using TerraZyme is high as compared to other chemical stabilizer but the benefit of using TerraZyme is that the maintenance cost is zero , making this approach economically cost effective.

2.6. SOIL STABILIZATION USING RBI GRADE-81

NeeleshRaghuwanshi, SuneetKaur studied effect of RBI GRADE- 81 on the engineering properties of soil and accounted following results for its ranging from 2%, 4%, 6% and 8%.
1.With the addition of RBI Grade-81 the plastic limit of soil increases and liquid limit of soil decreases and thus plasticity index of soil also decreases.
2.MDD decreases and OMC increases with the addition of RBI Grade-81 but the strength does not decrease with decrease of MDD.
3. With the addition of RBI Grade-81 and with the increase of curing period duration, the soaked CBR and UCS value also increases.
4. According to Tejinder Singh, NavjotRiar (2013) the cost of pavement decreases when RBI Grade-81 is used with soil to construct pavement. The cost of pavement for 2% RBI Grade-81 was found to be minimum among all the other cases of soil and RBI Grade-81 mix.
5.With the increase of RBI content, the free swell index of soil decreases.

3.Discussion

In developing country like India above mention stabilisers are much more useful because of present atmospheric condition is suitable to strengthen the subgrade soil by using these stabilisers.The results of this investigation have shown that beneficial effects are obtained by the addition of lime and waste to soil. Rice husk ash an agricultural waste can be effectively used for stabilization of soils using cement or lime as additive.
The bio-enzymes are non- toxic, organic and biodegradable in nature. These chemicals do not harm humans, animals, fish or vegetation in normal use. These are made from organic materials and are biodegradable.

The use of bio-enzyme in pavement construction is proven to be very economical as compared to other traditional soil stabilization methods. The cost of construction project can be reduced considerably with the use of bio-enzyme.
non- traditional additives like rice husk ash, crumb rubber, marble dust, blast furnace slag can also improve soil properties but are less efficient. But combining two or more non-traditional additive can improve their effectiveness. Non-traditional additives should be used as soil stabilizer as they provide an economical alternative and also help in waste disposal.

4.Conclusion

Traditional stabilizers like as fly ash, lime, cement can improve soil properties by themselves. non- traditional additives like rice husk ash, crumb rubber, Bio-enzyme, RBI grade-81 can also improve soil properties andeffect on soil properties is for long time.With the use of bio-enzyme, aggregate free pavement is possible as its use promotes the use of locally available material.Combining two or more non-traditional additive can improve their effectiveness. Non-traditional additives should be used as soil stabilizer as they provide an economical alternative.

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