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Improvement the Soil Subgrade using Sisal Fiber and Bagasse Ash

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ABSTRACT- The effects of addition of Bagasse ash and Sisal Fibers in soil on MDD and OMC relationship different percentages of bagasse ash is added and optimized. Then this optimized bagasse ash soil is the mixed with the different lengths and different percentages of Sisal Fibers. It is interpreted that there is increase in OMC and decrease in MDD with addition of Bagasse Ash. But the values of CBR and UCS are increased with 4% of BA and Sisal Fiber length 4cm at 1.5%. There is increase in the percentage of UCS, when sample were prepared with 2%, 4% by 3.02%, 4.70% and decrease in percentage of UCS,. The experiments in combined sample of BA and Sisal Fiber (2cm, 4cm, 6cm)shows that the maximum value of UCS are obtained at 4cm length with 1.5% by weight, which is found to be 3.73 kg/cm2. The percentage increase as compared to the raw soil is 25.16%. The soaked CBR value of the raw soil with 4% BA is 2.59%. The soaked CBR value of combined soil sample with 4% BA, 1.5% of Sisal Fiber of 4cm length is found to be 3.09%, the increase in CBR value as compared to raw soil is 70.16%.

KEYWORDS- Bagasse Ash, Sisal Fiber, OMC, CBR, MDD, UCS, CBR.

I. INTRODUCTION

The increasing construction cost of conventional stabilizers as well as requirement for the cheap consumption of industrial and agricultural wastes for valuable trade has provoked an exploration into the stabilizing prospective of bagasse ash and Sisal fiber for highly compressible clayey soil. This study aimed to assess the appropriateness of bagasse ash and Sisal fiber for stabilization of clayey soil[1][2]. But, costs of stabilizing agents are so high which make them inexpensively unappealing as stabilizers like bagasse ash, fly ash, RHA, coconut fibber's etc.
Normally there are two types of pavements:
(a) Rigid Pavement
(b) Flexible pavement

A. Principle OF Soil Stabilization

Soil stabilization is the process of enhancing the engineering characteristics of soil by amalgamating the stabilizers to increase the load carrying capacity, and resistance to weathering. A binding material or a chemical is mixed with raw soil for the stabilization [3][4][5]. It is required to improve the natural soils for increasing the bearing capacity of soils carrying heavy loads, reduce permeability, compressibility, durability and resistance to weathering.

B. Components of Soil Stabilization

Stabilization of soil is done by using stabilizers in soft soils to enhance its geotechnical features such as bearing capacity, permeability, and compressibility. The parts of soil stabilization include soils or soil minerals and stabilizing agents or binders. By stabilizing soil, this made the soil more stable thus enhancing bearing capacity of soil[7][8].

1) Soil

Most of the stabilization has to be undertaken in soft soils (silty, clayey, peat or organic soils) in order to achieve desirable engineering properties. Organic and peat soils are high in water content and high porosity. The uniformity of peat soil can differ from mucky to stringy. The deposit may be shallow, or it can extend to several depths below the ground level. Whereas organic soil due to high exchange capacity can delay the process of hydration by retaining the calcium ions which are liberated while hydration of calcium aluminates and calcium silicates in cement to make balance by adjusting the exchange capacity.

2) Stabilizing Agents

These are primary binders (hydraulic) and secondary binders (non-hydraulic) additives which when come in contact of pozzolanic minerals and water reacts with it to form composite of cementations characteristics. The usually used binders are:

- **Cement**: It is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel together.
- **Lime**: Lime is a calcium-containing inorganic mineral in which carbonates, oxides, and hydroxides predominate. In general, lime is calcium oxide or calcium hydroxide
- **Bitumen**: It is a black or dark-color, amorphous, material that can be found in different forms, (solid, semi-solid and viscous) such us rock asphalt, natural bitumen, tar and bitumen derived from petroleum. Bituminous stabilization is best for soils which are sandy or poor quality base course materials.
- **Fly Ash**: Fly ash is obtained as by-product from blast furnaces and is normally rich in alumina and silica. Though, the amount of fly ash essential for sufficient stabilization is fairly high, making its use limited to areas with ease of using large amount of fly ash at

comparatively low cost.

- **Fibers:** Natural and synthetic fibers are used in stabilizing the soft soils. Synthetic fiber are fibers made by humans with chemical synthesis, with little or no chemical changes. In general, synthetic fibers are created by extruding fiber-forming materials through spinnerets into air and water, forming a thread. Natural fibers are produced from renewable resources, which are biodegradable like banana, sisal, hemp and flax, jute,coconut, bamboo, sponges, wood dusts and oil[12][13].
- **Geo-synthetics**: Geo-synthetics are most recently used methods to strengthen the soil stratum, made from a variety of polymers like polyethylene, polypropylene, polyester, nylon, and polyvinyl chloride). Geo-textiles are elastic in nature, to control permeability by reinforcing the soil. Geo-grids are like sheets used mainly as strengthening of unsteady soil. Geo-cells are in shape of honeycombed sheets used to support in soil as a sub base.

II. PROPOSED METHOLOGY

A. Mechanical Stabilization

Mechanical stabilization involves physically changing the property of the soil somehow, in order to affect its gradation, solidity, and other characteristics. To achieve the desired grading, sometimes the soils with coarse particles are added or the soils with fine particles are removed[15][17]. It is also known as granular stabilization.extra aggregates may be mixed so that soil-aggregate mixture became uniform, well-graded and dense after compaction. Uniformly mixing the materials and compacting the mix can finish mechanical stabilization. This method is simplest and is usually used to get better sub-grades which are having low bearing capacity. It is widely utilized in the construction of sub-bases, bases and surfacing of roads.

Figure 1: Mechanical Stabilization

B. Cement Stabilization

Cement Stabilization is done by mixing pulverized soil and Portland cement with water and compact the mix to attain a strong material. There are three types of soil-cement like normal, plastic and cement- modified. Normal soil-cement contains about 5 to 14%of cement by volume. It is quite strong and weather resistant. It is commonly used for stabilizing low plastic and sandy soil. Plastic soil-cement contains about 5 to 14% of cement by volume, but it has more quantity of water to have wet uniformity. It is used on steep or irregular slopes where it is difficult to use normal road making equipment. Cement modified soil contains less than about 5 of cement by volume

Figure 2: Cement Stabilization

It is a semi-hardened product of soil-cement. It is quite inferior to the other two types shows fig 2.

C. Lime Stabilization

The resulting material is more fragile than the original clay, and is therefore, more suitable sub-grade. The quick lime is more effective as stabilize than the hydrated lime; but the latter is more safe and convenient to handle.shows fig 3.

Figure 3: Lime Stabilization

D. Bituminous Stabilization

Bitumen is non-aqueous systems of hydrocarbons that are soluble in carbon disulphide. It is generally done with asphalt as binder. As asphalts are normally too viscous to be used directly, these are used as cutback with some solvent such as gasoline. Organic soil which can be mixed with bitumen

Figure 4: Bituminous Stabilization

(asphalt) is used for bituminous stabilization. For sandy soils,asphalt binds particles of soil together and thus used as bonding or cementing agent whereas in cohesive soils, asphalt give protection to soil by plugging voids thus made it water-proof. It allows the cohesive soil to maintain low water

content and increase the bearing capacity. The total bitumen essential usually varies among 4 to 7% by weight. Shows fig 4.

E. Chemical Stabilization

In chemical stabilization, soils are stabilized by adding different chemicals. The main advantage of chemical stabilization is that setting time and curing time can be controlled, but it is however more expensive than other methods.

- **Calcium Chloride** – the soils treated with this do not easily pick up water, the method is effective for stabilization of silt and clay which having low strength while increase in moisture content. The quantity of this required is about one and a half percentage of the weight of the soil. It is primarily used for construction of roads in stabilizing bases and sub-bases.
- **Sodium Silicate –** the chemical is utilized as a water solution which is called water glass by injecting it to soil. The quantity of varies from 0.1% to 0.2% of the weight of soil.
  There are some other chemicals namely polymers, water proofing agents, water retaining agents, water retarding agents and miscellaneous chemicals.

F. Reinforced Fiber Stabilization

Early civilization utilizes plant roots, straws, and cob wall and soil bricks to get better properties of soil. However, new trends in geotechnical engineering determined on the application of distinct fibers reinforcement of soils which is a comparatively latest practice. The perception of fiber-reinforcement initially concerned the employ of plant roots. Most studies report that plant roots enhance the shear strength and subsequently, the stability of slopes. The shear strength under various testing conditions (consolidated drained, consolidated un-drained) increased with increasing fiber content and the mode of failure changed from brittle to plastic. The ductility of the specimen was also found to increase with increasing fiber content. Shows fig 5.

Figure 5: Reinforced Fiber Stabilization

G. In – Situ Stabilization

In this technique on-site enhancement of soil is done by application of stabilizers without clear off the bulk soil. By this methods profit of getting better soils for shallow foundations, deep foundations. This is done by methods of injecting and grouting. In grouting, stabilizers are used either in form of suspension or solution. The alternative to use either wet or dry mix depends on present soil conditions like moisture content, also on nature of construction and effectiveness of binders. This also achieved by injection of cementitious materials into soils like lime and cement in dry or wet form.

H. Ex- Situ Stabilization

In this method, clearing-off soils or sediments from present location to other place can be encounter through dredging of ports and river channel. It is usually not done for ordinary construction. Soil stabilization is extremely important as eventually, soil which supports the whole load.

III. FACTORS FOR STRENGTH ENHANCEMENT

To achieve soil enhancement we need to study the factors on which soil strength enhancement depends. Following factors are responsible for strength improvement:

- Moisture
- Temperature
- Compaction
- Chemicals
- Organic matter
- Freezing and thawing action.

IV. ADVANTAGES OF SOIL STABILIZATION

- To enhance soil properties so that it will bear load safely that will come on it by enhancing the bearing capacity. The advantages of soil strength enhancement are as follows:
- It enhances the durability, by increasing the load bearing capacity of soil.
- It is used to stabilize the slopes on hilly terrains.
- By stabilizing the soil there is very less chance of differential settlement and liquefaction.
- By enhancing the soil properties the workability and strength improved.
- It also reduces the soil erosion or formation of dust in dry, arid and semi-arid regions.

V. CONCLUSION

To study the effects of addition of Bagasse ash and Sisal Fibers in soil on MDD and OMC relationship different percentages of bagasse ash is added and optimized. Then this optimized bagsse ash soil is the mixed with the different lengths and different percentages of Sisal Fibers. It is interpreted that there is increase in OMC and decrease in MDD with addition of Bagasse Ash. But the values of CBR and UCS are increased with 4% of BA and Sisal Fiber length 4cm at 1.5%..

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