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STABILIZATION OF SUBGRADE BY USING ADDITIVES (CEMENT, LIME)

[1]Arif ur Rahman, [2]Adeed Khan, [3]Muhammad Hasnain

[1, 2,3]Department of Civil Engineering, Iqra National University Peshawar, Pakistan

ABSTRACT

This proposal comprise of literature survey on stabilization of subgrade layer of road structure using lime and cement. Pakistan consist of geographical diversity having different types of soils in different areas these types of soil includes sandy, clayey, silts, granular soil, black cotton soil etc. Some of these type of soil are having poor bearing capacity which are not suitable to bear the structural load of road.in order to improve these deficiencies of subgrade soil, stabilization technique are to enhance the bearing capacities of mentioned soils. For improvement of bearing capacity and strength of soil two process for stabilization are followed, that are chemical and mechanical stabilization.in mechanical process blending good quality soil in a required proportion used to improve the properties of subgrade soil. After this, spreading and compaction of blended soil is done. In chemical process stabilizing agents like cement, lime, flyash, saw dust ash etc are added to subgrade soil to impart properties like bearing capacities, CBR and strength of soil etc.
By using cement as a stabilizing agent different types of soils can be stabilized but it is very effective in sandy soil sand with silt soil and clay soil whose plasticity is within the range of low to medium and lime is prefer for clayey soil having plasticity index very high.

INTRODUCTION

Soil available in nature is very useful for both agriculture and engineering purpose. For engineering point of view, soil plays important roles in the construction of building, highway, railway, airport, harbor, dams etc. as basic foundation material. strength is different for different types of soil, incase soil having the low strength for the particular structure at the site it is required to improve the strength of soil by using stabilization technique. Soil stabilization requires the identification of its stabilization goals , select the right type, ratio and amount of stabilisers.in order to achieve the designed goals of soil stabilization evaluate the subgrade soil properties. Goals of soil stabilization consist of providing proper working platform, reduce plasticity index (PI),liquid limit (LL) of soil, improve CBR values and soil density, reduce shrink or swell characteristics of the soil, improve strength and stability of soil, reduce moisture content. Many soils such as clayey, black cotton soil having a tendency of swelling and shrinking, with the variation in the amount of moisture. So this change in volume of the soil can be unfavorable to any structures built on such soil. Many methods of stabilization have been used to minimize the LL, PI, shrink/swell properties and thus to get rid of effective damage.
Soil stabilization is an economical (lime and cement) and environmental friendly (fly ash) process for changing behavior of soil such as chemical and mechanical through pozzolanic

reaction. For many years, researchers have done soil stabilization through the utilization of additives including cement, lime, industrial waste products, fly ash, and calcium chloride. Now a days using lime, cement, fly ash, and their combinations for Chemical stabilization of the soil is very common. Among them lime is the most widely used admixture as they form cementing material which bonds the clay particles and increasing their density thereby reducing the plasticity, shrinkage, swelling and improve the strength characteristics. More over Emerging trend of using waste material in soil stabilizing or soil strengthening is being operational all over the world in present days. The main reason behind this trend is the excessive production of waste like fly ash, plastics, rice husk ash which is not only hazards but also creating deposition problems. Using some of these waste materials in construction practice will reduce the problem in a great extent. [3]

LITERATURE REVIEW

According to the findings of [2] At soaked conditions there is no such fluctuation occur in strength factor and resistance to deformation between combined and asphalt stabilization. At 2.54 mm penetration in (combined, lime, and asphalt)the CBR values decreased by 55,53,and up to 40%.settlement occur ratio is higher in untreated soil, when the impact load reaches to 220kpa the settlement increases sharply. when stabilization is done with combined , asphalt emulation ,and lime the settlement decreases by 69,86,and 76%.after treating with asphalt lime and combined stabilization the failure stress increases by 25,37.5 and 12.5%.after implementation of asphalt emulation, lime, and combined stabilization the modulus of sub grade reaction was increased by 16.6,400,and 220% respectively.

[1] M.S in his research investigate with two types of stabilizers that is lime and cement stabilization. His research includes the long term durability of stabilized swell clays with prominent clay mineralogy by treating with wetting/drying studies. This study includes the variation in moisture content that occur during seasonal fluctuation.at regular interval volumetric strain and unconfined compressive strength of the soil sample were examined at selected cycles during wetting/drying intervals. With the help of leachate apparatus the soil samples were examined under heavy rainfall conditions. According to research Mineral Montmorillonite has a significant effect on the stabilization effectiveness of clays where poor performance of stabilized soils during durability studies was observed when there is a percent increase in mineral occurs.

According to findings of [2] By adding saw dust ash the properties of soil like plastic limit, plasticity index, specific gravity, unsoaked CBR and unconfined compressive strength of treated soil were improved. Reduction occurs in maximum dry unit weight by increasing amount of saw dust ash. This research found that adding 4% sda ,CBR values increases by 103.11%and other property like unconfined compressive strength increases by 26.35.Saw dust ash was found is in economical stabilizing additive for subgrade and sub base in clayey soils. The main importance of this additive is that it results in the reduction of construction cost of roads especially in rural areas of developing countries like India.

According to the research of [4] Lime stabilized expansive soil and untreated soil were subjected to a surcharge pressure of 25kpa and examined for a set of cycles of swell-shrink tests. When an equilibrium stage is attained between the treated and untreated samples the swell-shrink path became elastic, where the vertical displacement as a result of swelling and

shrinkage remains unchanged. After three cycles balance conditions were attained by untreated and lime stabilized samples. Within the cycles maximum swelling occurred at the second cycle for all samples that were subjected to tests. After adding 2% of lime it was observed that the vertical deformation of untreated sample was reduced to a third and after adding 3% lime vertical deformation was reduced to a sixth. According to his findings when the soil was treated with 2%lime the gradient of swelling and shrinkage path for the untreated expansive soil reached .82 was reduced to a sixth and this gradient decreased to a third when it was treated with 3% lime. This research suggests that at higher degree of saturation the treated sample attain maximum swelling while untreated sample donot.in order to simulate the field condition for short term after compaction it is very important to measure swelling value from the first cycle.it is also very necessary to account the climate cycles in order to simulate the field condition for long term.

METHODOLOGY

For treatment of subgrade soil two types of stabilizing agents were selected.

a) CEMENTAS SUBGRADE STABILISING ADDITIVE

A wide range of soil types can be stabilized by using cement but it is very effective in sandy soil, sand with silt soil and clay soil whose plasticity is within the range of low to medium. When the soil having high plasticity index the first preference is to use lime to reduce its plasticity index and then by using cement it will become more effective. Generally use the lime for clay and cement for sands which is use as a thumb rule.

There are four techniques by which soil can be improved by using cement. Major two prominent techniques are hydration (cement water reaction) and cation from cathode exchange, while other reactions which include carbonation and pozzolanic reactions playing a minor part in the process.

Cement is composed of many compounds which make them a complex mixture. Major compounds are C3S, C2S, C3A, and C4AF.for creating favorable environment for stability of subgrade, it is necessary to increase the PH of water, for this calcium hydroxide is used.

For stabilities of subgrade soil the second most important technique is cation exchange .in crystalline structure of clay the cation from the cement fills the empty space or exchange their locations with another cation. Due to this exchange the net surface charge of clay particle decreases which results in lesser attraction for free water molecules.

The lime (CaO) which is formed within water cement reaction (hydration) of cement reacts with carbon dioxide which is found in the air and produces compounds of calcium carbonate which have cementations properties.

The lime which is produced during the hydration process of cement reacts with alumina and silica ions of subgrade soil which form cementations material and strengthen the bond with the subgrade soil. [5]

b) LIME AS A SUBGRADE STABILIZING ADDITIVE

In order to increase the workability and strength and for reducing the plasticity index and swell, lime is added to subgrade soil. Kaolinite reacts slowly with lime as compare to montmorillonite. The soil with plasticity index greater than 30 should be treated with lime up to certain level to decrease its Plasticity index to at least 30 and then it is treated with cement. For stabilization PH of the soil plays a prominent role.at site soil containing PH equal to or greater then are highly reactive to lime as compare to those soils having PH less than 7.

In order to increase the workability of soil many process and chemicals have been used in the early time. In these processes the most advantagable is lime stabilization for subgrade stability. For a clay content grater then 25-30% and volumetric change greater than 20-30% and PI greater than 15-18 which are the physical properties of high clay content soil lime is used on the priority basis. [6]

Understanding the lime soil reaction thorough examination of montmorillonite structure of clay is necessary. When the water layer size decreases due to cation exchange, the minute clay particles through adhesion come close to each other retract through agglutination.

The soil adopts non plastic properties with the increase in lime content in subgrade soil. OMC increases and MDD decreases with the mixing of lime in subgrade soil. With the mixing of lime in subgrade soil the swell potential can also be decreased. The best way to choose the optimum lime content and to find the shear strength, unconfined compressive strength is used.

Depending on the soil type, amount of lime vary from 4 to 6 %.The greater percentage of lime should be used for low quality subgrade soil. The values of stabilization should be a minimum of 15cm, 20-23cmand 25-30cm deep for marginal soil, poor soil and worst soil respectively. [7]

CONCLUSIONS

- Subgrade is the lower most layer of road structure.
- Subgrade should be stabilized to bear the load of other road layers and also to take loads of repeated traffic load.
- For this stabilization we usually use two types of additive agents that are lime and cement stabilization.
- In order to increase workability and strength and to reduce the plasticity index and swell, we add lime to the subgrade layer of road.
- For the soil having the plasticity index greater than 30 first lime is added to reduce its plasticity and swell.
- There are three types of clay minerals namely kaolinite, montmorillonite, and illite. kaolite reacts more fastly than montmorillonite.
- Subgrade layer of road can also be stabilized by using cement as a stabilizing agent.
- Cement is very effective in sandy soil, sand with silt and clay, for these types of soil cement is the best stabilizing agent.
- When plasticity is within the range of low to medium the prior stabilizing agent is cement.
- Calcium hydroxide is used to increase the PH of water that provide the favorable environment for the stability of subgrade soil.
- As a result of hydration process of cement lime is produced which reacts with alumina and silica ions that imparts the cementations properties which strengthen the bond with subgrade soil.

RECOMMENDATIONS

- This study includes the stabilization of subgrade soil by using two stabilizing additives that are cement and lime. other research suggests different types of additives can also be used which includes bitumen, flyash , waste paper sludge ash, bentonite ,saw dust ash, rice husk ash.
- Fly ash is activated by cement which makes it an affective agent for the stabilization of subgrade soil.
- Bituminous stabilization resists the settlement of subgrade soil.
- By adding the saw dust ash (SDA) to subgrade soil the properties can be enhanced.
- Due to the incorporation of small amount of waste paper sludge ash (WPSA)results in the crystal formation due to the pozzolanic reaction gives us significant stabilization to subgrade soil.
- Some of the above mentioned stabilizing agents contribute to the pollution of environment so if they are added to the subgrade soil as stabilizing agents reduces the environmental pollution, and they are also very much economical.

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