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A REVIEW PAPER ON USE OF BIO-ENZYME

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ABSTRACT

Rural Connectivity becomes a critical component in the socio-economic development of rural people by providing access to amenities like education, health, marketing etc. It has been established that investments in rural roads lifts rural people above the poverty line. The evidence also indicates that as the rural connectivity improves, the rural poverty levels come down. Economy of the nation is reliant on road infrastructure for which the roads should be intended to meet the steadily changing burdens and environment. Economy of the nation is reliant on road infrastructure for which the roads should be intended to meet the steadily changing burdens and environment. Attributable to boom in vehicle development, vehicle load on our road is expanding quickly which requests for good nature of subgrade from economical design perspective. It turns out to be expensive to utilize soil having subgrade with low CBR worth to endure heavy loaded weight of vehicles, these requires the interest for enhancing the quality of subgrade utilizing stabilizers to enhance the CBR values, so that less thickness of asphalt can be designed with no bargain with quality of asphalt development. Bio-enzyme is a natural, non toxic, non flammable, non-corrosive liquid enzyme formulation fermentedfrom vegetable extracts that improves the engineering qualities of soil, facilitates higher soil compaction densities and increases stability. Enzyme catalyze the reactions between the clay and the organic cat-ions and accelerate the cat-ionic exchange process to reduce adsorbed layer thickness. For other types of chemical stabilization, chemicals are mixed with soil, which is difficult to mix thoroughly, but bio-enzyme is easy to use as it can be mixed with water at optimum moisture content and then it is sprayed over soil and compacted In recent past many Bio-Enzymes have come to the market which can be used as stabilizing agent. One such stabilizing agent is TerraZyme, which is used in the present investigation to further stabilize blended soil.Bio-enzymes available for soil stabilization such as renolith, Perma-Zyme, Terra-Zyme, Fujibeton etc. These enzymes have been proven to be very effective and economical. Another advantage of the bio-enzyme is that these are environment friendly. When these bio-enzymes are mixed with soil they alter its engineering properties UCC, CBR with longer curing period

Keywords: CBR value, Bio-Enzyme, Terrazyme, Renolith

I. INTRODUCTION

The BC soil covers impressively vast zone, almost one - third, of Indian area. It is portrayed by high shrinkage and swelling properties and hence forth the BC soil has been a test to the thruway engineers. Soil is the crucial segment of this nature and road improvement industry knows the essentialness of it for asphalt work. As of late numerous specialists have been attempting to utilize business chemicals, enzymes and so on to upgrade the soil execution. Bio-Enzymes may give some extra shear quality to some soils and henceforth the soil adjustment with compounds ought to be considered for different applicat ions however just on a case -by-case premise to fulfill financial use of advancement materials by trying to keep the wastage of soil material through the change of its properties to meet the essentials of asphalt arrangement from its arranged use. Bio -Enzymes are synthetic, natural, and fluid concentrated substances which are utilized to enhance the soundness of soil sub -base of asphalt structures in order to satisfy specific outlining road endeavours and organization life of the black-top.

An enzyme is by definition an organic catalyst that speeds up a chemical reaction, that otherwise would happen at much slower rate, without becoming a part of the end product. Since the enzymes do not becomes the part of end product and are not consumed by the reaction, a very small amount of bio enzyme is required for soil stabilization. They are organic molecules that catalyze very specific chemical reactions if conditions are conducive to the reaction they facilitate. For an enzyme to be active in a soil, it must have mobility to reach at the reaction site. The pore fluid available in the soil mass provides means for mobility of the molecules of bioenzyme, the specific soil chemistry provides the reaction site, and time is needed for the enzyme to diffuse to the reaction site. An enzyme would stay active in a soil until there are no more reactions to catalyze. Enzymes would be expected to be very soil specific Each enzyme is specifically tailored to promote a chemical reaction within or between other molecules. The enzymes themselves are unchanged by these reactions. They serve as a host for the other molecules, greatly accelerating the rate of normal chemical and physical reactions. The enzyme allows soil materials to become more easily wet and more densely compacted. They also improve the chemical bonding between soil particles and creating a more permanent structure that is more resistant to weathering, water penetration and wear and tear. Some information about commonly available bioenzyme products and their probable stabilization mechanism are discussed in following points.

II. GROUND IMPROVEMENT TECHNIQUES

One of the proven technologies for the use of local soil and marginal aggregates is stabilization. The stabilization can be mechanical or chemical and several types of stabilizing agents have proved to be suitable under different conditions of soil and environment. The soil stabilization techniques include:

- Stabilization with lime.
- Stabilization with cement.
- Stabilization with a combination of lime and cement.

Even though specifications for soil stabilization are included in both MoRT&H and MoRD book of specifications their adoption is not getting popular, due to problems associated in attaining homogeneity of soil-stabilizer mix in the field and achieving the desired results. The only constraint in the use of the above techniques lies on the procedures adopted in the field. It is possible to popularize the use of stabilization techniques through appropriate training and capacity building of the field engineers. Further, development of low end technology equipment, for use in the rural roads also facilitates wider use of these methods. In addition to the above, several methods are being tried with the use of industrial waste by products in road building.

The following are some of the important materials which have proved good.

- Fly Ash for the construction of the embankments and stabilization of sub-base and base-courses.
- Steel and copper slags for the construction of sub-base
- and base-courses.
- Marble dust in sub-grade and sub base.

Though the construction of different elements of the road with Fly Ash has been successfully implemented, the use of other materials is not so widely adopted except for inplant roads. However, construction technologies with the use of such materials can also be successfully adopted, if the field engineers are properly trained. Studies were carried out on the use of waste materials like rice husk ash and lime sludge. These materials, if left unused, may affect the surroundings and also create problem for their disposal. Use of those waste materials in road construction can alleviate the problem of their disposal to great extent. In India, studies were conducted at CRRI, IIT Roorkee and several other places for their use in stabilizing the soil. The results indicated that heir usage has great impact on the improvement of soil properties. The studies suggested that they are very useful for stabilizing clayey soils. The summary of the results indicate the following:

- Improve Atterberg limits to make soil suitable for road building.
- Increase the unconfined compressive strength of soil as well as CBR.

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III. ALTERNATE TECHNOLOGIES IN CONSTRUCTION

There are several other techniques that can be adopted in conditions of low bearing capacity soils, marshy lands and location with drainage problems such as the use of geotextiles.Several types of geo-textiles including synthetic, jute coir etc. are proved to give good results and provide cost effectiveness for rural roads.

A. Use of Jute Geo-textile

Jute Geo-textile (JGT) is a kind of natural technical textile laid in or on soil to improve its engineering properties. It is made out of yarns obtained form the jute plant. Jute Geo Textiles have high moisture absorption, excellent durability, high initial tensile strength, biodegradable and improved soil structure on degradation. The basic functions of JGT Road Engineering are separation, filtration, drainage and initial reinforcement. It is environment friendly. Jute Geotextiles can be more effective, eco-friendly and economical if used judiciously and jointly with other measures.

Fig:3.1:Use of Jute Geo-textile

B. Flexible-Concrete Pavement Technology

IIT Kharagpur has developed a new technology for low cost cement concrete road construction, which has proved to be suitable in place of conventional CC roads for low volume traffic. Even though the initial cost of flexible concrete road is high compared to cost of conventional flexible pavement, the life cycle cost with maintenance costs over a period of 10-20 years is less compared to the conventional one. The technology consists of placing a form work of plastic cells 150 x 150mm and 100mm deep over the prepared foundation of road and placing zero slump concrete in the cells and compacting with road roller/ plate compactor / earth rammer. On curing, a flexible-concrete pavement is obtained which will not wear even under iron tyred carts if aggregates of good quality are used.

C. Use of Waster Plastic Blended Bitumen

It is possible to improve the performance of bituminous mixed used in the surfacing course of roads. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low – temperature cracking of the pavement surfacing. Laboratory studies were carried out at the Centre for Transportation Engineering of Bangalore University, in which the plastic was used as an additive with heated bitumen n different proportions (ranging from zero to 12% by weight of bitumen) The results of the laboratory investigations indicated that, the addition of processed plastic of about 8.8% by weight of bitumen, helps in substantially improving the stability, strength, fatigue life and other desirable properties of bituminous concrete mix, even under adverse water-logging conditions. The additions of 8.0% by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4% bitumen by weight of the mix or about 9.6% bitumen per cubic meter of BC mix.

Fig:3.2:Use of Waster Plastic Blended Bitumen

D. Cold Mix Technology

Cold mix is a mixture of unheated aggregate and emulsion or cutback and filler. The main difference between cold mix and HMA is that aggregates and emulsion or cutbacks are mixed at ambient temperature (10°C-30°C) in case of cold mix and aggregates and binder are mixed at high temperature (138°C-160°C) in case of HMA. Dense graded cold mixtures have far lower permeability and good resistance to deformation. Open graded mixtures mare storable and semi dense mixtures have good adhesion and lower permeability

Fig:3.3:Cold mixTechnology

Cold mix when used as paving mix can offer following advantages.

- It eliminates heating of aggregate and binder.
- It is environmental friendly and conserves energy. Cold mix pavement can provide energy savings of over 50% compared with hot mix. So it can be considered as green bituminous mix for rural road construction.
- It can be easily prepared using small set up on site. It can be produced manually for small scale job. Laying of HMA for rural road construction sometimes is not economical because setting up of a hot mix plant for small scale job increases the project cost.
- This paving mix is particularly suited for construction of roads in remote and isolated areas of a country where plant produced hot mix may have set before reaching site.
- Cold mix can be laid during wet or humid condition also.
- It is versatile also as a large number of grades of emulsion and cutbacks are available.
- It is economical and high production is possible with low investment.

In India majority of road network is occupied by bituminous pavement only in which Hot Mix Asphalt (HMA) is used predominantly as a paving mix from many decades. However this bituminous mix is associated with some limitations. These include excessive emission of greenhouse gases (e.g. sulfur dioxide, nitrogen oxides, carbon monoxides and volatile organic compounds) from HMA plant, shut down of hot mix plant during rainy season and the laying of HMA is difficult in hilly areas and rural areas having long hauling distances, cost of putting up HMA plant is high and comparative budgets of small sections of rural road is very less, etc. As, Indian rural road network is developing continuously, paving mix like cold mix asphalt or Warm Mix Asphalt (WMA) should be tried. This mix is started to lay on pavement to reduce the problems associated with HMA. Warm mix asphalt is a very new technology compared to cold mix asphalt.

Construction of rural road using conventional paving mix is sometimes not feasible in high rainfall area because it is difficult to produce and lay HMA. In case of high altitude or snow bound area, lower temperature of environment makes difficult to heat aggregate and binder at high temperature. In case of hilly roads, HMA is supplied from remote HMA plant; it is difficult to maintain mix temperature for long hauling distance. Cold mix can be produced on site. Simple concrete mixture, motor pavers or specialized mixing plant can be used to produce cold mix on site. Cold mix can be lay down by hand for small scale job and compaction is carried out by vibrating roller. Hence Cold mix asphalt should be tried in India for construction of rural roads in hilly areas having high rainfall and difficult terrain.

IV. BIO-ENZYME UNDER DIFFERENT NAMES

A.Renolith

The Renolith patented product was developed in Germany. Renolith and the cement polymer-forming road stabilization chemical was further developed in Australia in 1995–96. Renolith significantly improves the strength of soil in thencement stabilization process in a variety of roads such as heavy haul roads, highways, rural roads, pathway construction, hard stands and rail earthworks capping. It also improves the flexibility of standard cement stabilized pavements.Renolith's usual application is as a mixture with water in specific proportions. This mixture is then applied to a cementbased aggregates or in-situ soils from fine sands to high plasticity clays. Renolith when thoroughly mixed and stabilized with a soil or road pavement material, cement and water produces an exothermic chemical reaction and forms a polymer which when compacted provides a very dense layer.The use of Renolith, under geotechnically controlled conditions, enables the pavement designer or contractor a number of options for pavement construction using the material available at site. It is a cost effective method of subgrade Enhancement and pavement rehabilitation.

Fig: 4.1:Renolith

1. Advantage of Renolith

a) With the use of renolith, about 20 to 40% reduction in the cost of pavement construction can be achieved.
b) There is no need to import an aggregate of required specification, hence locally available material can be used.
c) Renolith provides adequate flexibility and durability to the pavement and avoids the formation of cracks.

2. Experimental Study in India

Renolith technology has been used in some projects by the Public Works Department of Arunachal Pradesh State, in India and reported cost reduction of about 20 to 30%. P.W.D. Rajasthan has also undertaken some works with Renolith in 2001. The pavement construction projects which have been completed using this chemical with considerable success are as follows :

a) Lumla township roads under CRF and Zimithang ring road under RIDF;
b) Dirangdzong-Namthung-Sangti road under CRF and Nafra-Nakhu road under NLCPR;
c) Lhou to Mukto road under NLCPR
d) Shergaon-Doimara road ;
e) Road from PWD IB to Bali at Seijosa under RIDF.

B.Perma-Zyme

It is a compaction enzyme, when it is added to asoil and aggregate mixture; it causes the compaction of clays and silts with a much faster rate than that occurs in nature.According to the manufacturer, this enzyme is a natural organic compound, similar to proteins, which acts as a catalyst. Their large molecular structures contain active sites thatassist molecular bonding and interaction. The organicformulation is designed to maximize compaction and increasethe natural properties of soil to optimal conditions. Thisenzymatic stabilizer increases the wetting action of water tohelp achieve a higher density during compaction and theformulation accelerates cohesive bonding of soil particles,creating a tight permanent stratum.

Fig: 4.2Perma-Zyme

1. Mechanism of Stabilization

Perma-Zyme lowers the surface tension of water, whichpromotes fast and thorough penetration and dispersal of moisture. This action causes hydrated clay particles to bepressed into and to fill the voids throughout the soil, thus forming a tight, dense permanent stratum. Specifically, PermaZyme combineswith the large organic molecules in the soil to form a reactant intermediary, which exchanges with the claylattice, breaking down the clay structure and causing thecover-up effect, which prevents any further absorption of water or the resultant swelling with loss of density. This isaccomplished by changing the substrate molecules of the clay (polarity of electro-negativity, ion exchange of the atoms). The engineering and index properties of soil such as plasticity, liquid limit, shear strength, swelling and shrinkage are altered by releasing pore water in the clay molecule due to which itprovides more dense, cohesive and stable binding properties. The increased density lowers water permeability and discourages the migration of moisture through the soil. The enzyme is regenerated by the reaction and goes on to perform again. Because the ions are very large, little osmotic migration takes place, and intimate mixing is required. This is generally aided by the destructive effect of the organic ions on the clay lattice.

2. Advantages of Permazyme

Few peer-reviewed studies have been published on enzymatic stabilizers. Khan and Sarkar reported increases in unconfined compressive strength with the addition of 5% enzymes and good performance in freeze-thaw testing

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a) Perma-Zyme increases the lubricity of soil particles which allows the designated soil density to be reached with less compactive effort.
b) It promotes rapid saturation and inhibits surface evaporation, thus reduces the requirement of water upto 25% of the O.M.C.
c) Perma-Zyme is environmentally friendly and biodegradable.

TerraZyme

TerraZyme is a natural, non-toxic liquid, formulated usingvegetable extracts and accepted all over the world as a soundand resourceful road building practice, which completely replaces the conventional granular base and the granular subbase, it emphasizes on strength, performance and higherresistance towards deformation. TerraZyme is speciallyformulated to modify the engineering properties of soil. Theyrequire dilution in water before application. The use ofTerraZyme enhances weather resistance and also increasesload bearing capacity of soils. These features are particularlyevident in fine-grained soils such as clay in which theformulation affects the swelling and shrinking behavior. Thisformulation has the ability to change the matrix of the soil sothat after compaction the soil loses its ability to reabsorb water

and the mechanical benefits of compaction are not lost evenafter water is reapplied to the compacted soil. Once theenzyme reacts with the soil, the change is permanent and the product is bio-degradable.

1. ***Mechanism of Stabilization***

TerraZyme reacts with the adsorbed water layer of clayparticle and reduces the thickness around the soil particle due to which void between the soil particles reduces and the soilparticle gets closer orientation with lower compactive effort.This decreases the swelling capacity of the soil particles and also reduces permeability.

Fig: 4.3 Application of TerraZyme to subgrade

2. ***Advantages of Terrazyme***

- TerraZyme increases the durability of pavement andreduces swelling properties of soil.
- Reduces construction cost by about 20-40% due toreduction in the transportation of materials and reuseof onsite materials.
- The use of TerraZyme enhances weather resistanceand improves load bearing capacity of soils.

3. ***Experimental Study in India***

In India TerraZyme has been used to construct a state highwayon black cotton soil in Nasik, Maharashtra. Some trial roadsare also constructed in states of Tamil-Nadu, Kerala andKarnataka. In Maharashtra, Public works Department hasconstructed two roads using TerraZyme and a cost reduction of 18-26% is reported.It is reported that Central Road Research Institute, India, conducted laboratory tests on three types of soil- Marine clay,Cuddalore soil and Pondicherry soil treated with organic bioenzyme liquid stabilizer. The soil samples were tested forCBR, Unconfined compression strength, swelling index andindirect tensile strength. It is reported that there wassignificant improvement in CBR value after four weeks of curing from 1.2% to 4.5%. The unconfined compressive strength was also found to increase by 104% upon treatmentwith bio enzyme and cured for 4 weeks.

V. CONCLUSION

a) Bio Enzymes are non poisonous, organic and biodegradable in nature. The product formed after the application of TerraZyme is bio degradable in nature and the effect is permanent. TerraZyme eliminates the use of granular sub base and sub grade course.
b) 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.
c) Bio-enzymes reduce swelling and shrinkage properties of highly expansive clays.
d) Use of bio-enzymes results in higher compressive strength and increased hardness of stabilized soil.
e) With the use of bio-enzyme, aggregate free pavement is possible as its use promotes the use of locally available material.

REFERENCES

1. *VenikaSaini,PriyankaVaishnava,Soil stabilization by using terrazyme, International Journal of Advances in Engineering & Technology, Aug., 2015,Vol. 8, Issue 4, pp. 566-573*
2. *A.U.Ravishankar, HarshakumarRai,I.RameshMithanthaya,BioEnzymeStabilised Lateritic Soil as a Highway material,Journal of the Indian Roads Congress, July-September 2009,paper no.553.*
3. *JoydeepSen, Jitendra Prasad Singh ,Stabilization of Black Cotton Soil using BioEnzyme for a Highway Material ,International Journal of Innovative Research in Science,Engineering and Technology ,Vol. 4, Issue 12, December 2015,pp.12453-12459.*
4. *Vijay Rajoria, SuneetKaur, A review on stabilization of soil using bio-enzyme,International Journal of Research in Engineering and Technology,Volume: 03 Issue: 01 ,Jan-2014 ,pp.75-78.*
5. *Saurabh B. Gautam, C. B. Mishra, N. F. Umrigar,Subgrade Soil Stabilization using Terrazyme,IJARIIE, Vol-2 Issue-3 2016 ,pp.2522*