

## A review: Revolutionizing Soil Stabilization through Bio-enzymes

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### Abstract

The present study investigates the cons and pros of bio-enzyme. Various soil stabilizing techniques that can be used to improve the quality of the soil by transforming its structural properties [1]. The aim of this study is to provide a guide about the functionality of bio-enzymes. Bio-enzymes can be utilized in multiple ways. Several experiments have been conducted to study its effect on soil stabilization. It was found that bio-enzymes prove to be beneficial for plants as well as for road constructions. These natural cleaners are able to meet the needs of making soil fertile. Its easy availability, low refund value and no contamination classifies it as a better means of conditioning agent than manure. Bio-enzymes are known to sustain nature and improve the quality of life.  $\alpha$ -amylase being used as a bio-enzyme aids in fermentation process by undergoing starch hydrolysis.

Using TerraZyme, a natural protein that elevates the Engineering properties of soil. It is known to reduce the thickness and making the product bio-degradable in a few cases. It acts as a catalyst and digests the biological soils.

**Keywords:** Soil stabilization; Bio-enzyme; Terrazyme; Black cotton soil; Geotechnical engineering

### Introduction

Soil stabilization or soil conditioning refers to the changing and improving structural properties of soil. It could be chemical or mechanical. Some of the factors are checked such as soil erosion, dust prevention, raised soil density and durability [2]. The significance of soil stabilization is that it increases the structural integrity of the construction on the soil and is an integral part of road construction. In these years bio-enzymes are used at higher pace for conditioning replacing the standardized methods. The standardized methods are sustainably adverse and emits greenhouse gases. As it has been quoted that the quality of soil gets altered through soil conditioners these are a combination of organic matter blended with larger particle size to let the soil open. Conditioners are better than manures as Earthworms, Fungi and Bacteria break down the nutrients for better absorption and improve its overall structure and texture. It involves physical, chemical, and biological means [3].

Soil lacking durability and stability bio-enzymes are used for meeting the desirable outcomes. The improvisation in the soil quality is done by increasing the dry weight which would increase the volume, subsoil and bearing capacity. However, the standardized methods like Ground freezing, Vacuum Consolidation, Soil Nailing require large sums of money and funds. Considering the increasing population, the raw materials needed for stabilization are getting deficient. At present using innovation Bitumen, Hydrated lime and Portland cement are used for conditioning [4]. For a longer period, these bio-enzymes prove to be crucial for plants health and soil overall structure.  $\alpha$ -Amylase acts as a bio-enzyme it undergoes starch hydrolysis which is essential for the conversion of starch into oligosaccharides. This enzyme helps in development of fermentation processes.

The bio-enzymes are introduced and absorbed by the clay. During this absorption process the caption reduces the thickness of the diffuse double layer. Another method when bio-enzymes are introduced into the soil they catalyse the reaction in which the neutralization of the negative charge which occurs when large organic molecule covers the surface area of smaller particles [2].

The significance of bio-enzymes is in various spectrums-

- Easily available, pocket-friendly
- Decrease carbon emissions and pollution.
- There is no contamination unlike the standardized methods.
- It ensures stability of the soil and improvisation in horticultural applications.

Nature has always come to rescue the diversity on our mother earth. Standardized stabilization or conditioning causes adverse effects to the soil texture and its structure [3]. The chemical methods used helps in improving the outlook of the soil and it poses no threat to ecology of the soil. It is non-toxic as it is derived from nature via organic matter. In every household the practice to make soil fertile can be conducted hence would sustain an eco-friendly environment.

### The advantages of bio-enzymes

Bio-enzymes act as a catalyst, and they are known to be useful for the cancer therapy especially when homogenized with the nanoparticle to improve the accumulation into the uncontrollable cell growth sites. Bio-enzyme based Nano medicines enhance the cancer therapy and they can deliver the toxic bio-enzyme into cancerous cells which directly causes apoptosis. By regulating the tumour microenvironment for instance pH, glucose concentration, and hypoxia and redox levels. Bio-enzyme based Nano medicines are known to boost the efficacy of the treatment [5]. The bio-enzyme degradation in tumour endocytosis which tremendously increases the penetration and retention of the nanoparticles [6].

The organic solutions produced by the fermentation of fruits

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and vegetables. Sugar and water are also the by-products. These bio-enzymes are known to use good bacteria for digesting wastes, soils, stain, and bad odours. Bio-enzymes are functional, a natural cleaner obtained from Agro-wastes [7] Bio-enzymes are an excellent non-standardized solutions to harsh chemicals. Amino acids, salts and other by-products can be used to make bio-enzymes [8].

The bioactive compounds are known to elevate the value and creating derivatives from plants. The botanical extract attained is augmented with reducing sugars, phenolic content, and peptide by disrupting lignocellulose and releasing the compounds from the cell walls and cytosolic [9].

Bio-enzymes have been put up for treatment of contaminated water and usage at homes. The composting curbs soil fertility therefore bio-compost which is prepared from solid residue is tested for the natural manure and checked for the usability [10]. Bio-enzymes have multiutilities. They help in waste reduction, sustain nature, and improve the quality of life.

Research was conducted on Salmonella biofilm that gets formed under the meat processing environment. The outbreak of Salmonella typhi in association with contamination is known to have a biofilm which is an assemblage of microbial cells irreversibly associated with a surface and is enclosed in a matrix of primarily polysaccharide material. During the research four surfactants and five bio-enzymes were used. Cetyltrimethyl ammonium bromide and Sodium dodecyl sulphate reduced greater number of biofilms. The study therefore indicated that CTAB when combined with cellulose will drastically remove the biofilm formed under meat processing environments [11].

### The experimental study in India

A soil Fertilizer namely Fujibeton is used to harden the soil. Roads constructed within the campus of NCCBM's in Ballabgarh [12]. It is advantageous as it does not create any shrinkage cracks which make it suitable for clayey/Soils. It is economical. One of the bio-enzyme used in the field of soil conditioning is TerraZyme.

Biodegradable substance improves the soil quality and gives better results in the field of geotechnical engineering [13]. TerraZyme consisting of a natural protein, Soluble in water. Black cotton soil is known for its plasticity properties with swelling potential [14]. The reduction in moisture will increase the shrinkage. However, when this soil was treated with TerraZyme during the experiment there was an elevation in the engineering properties of the soil [15]. Samples of treated and untreated soils and reached to a conclusion where there was reduction liquid limit, plasticity index, and optimum moisture content and compression index. The cohesion and angle of shearing resistance was found to be increased [16]

### Gap areas in the field of bio-enzymes

Toxicity of bioremediation agent with microbiological environment in marine organisms. In one of the tests conducted to infer the potential toxicity of seed culture of petroleum degrading bacteria, TerraZyme, it resulted in fish toxicity of TerraZyme wherein the fishes were reared in water containing bio-enzyme [17]. Fishes for example *Plecoglossus altevelis* (sweet fish) were kept separately and fed on a food containing TerraZyme. The impact was found negative [18, 19].

Limitations of bio-enzymes have narrow thermo stability, narrow substrate scope. These can be allergic to people. Their susceptibility to denature because of temperature, pH and poisons is a drawback. While performing the experiments the reactions might turn get contaminated [19-21]. The available enzymes cannot completely break a cell wall.

Enzymes work rigidly by the environmental conditions due to which the extraction is not feasible. Standardization, instability of the enzyme can mislead the results during storage.

### TerraZyme

TerraZyme is one of the non-toxic liquids which is formulated using vegetable extracts. It is known to believe higher resistance towards deformation. It shows swelling and shrinkage behaviour and has capability to change the matrix of the soil [7]. This enzyme reacts with water and gets absorbed to reduce the thickness around the soil particle. Once the reaction takes place, the change occurred becomes permanent and the product is biodegradable [22]. In India the experimental study was carried out to construct a state highway on black cotton soil in Nasik, Maharashtra including other road trials in the states of Tamil Nadu, Kerala, and Karnataka. After adopting this method, the cost reduction was about 18-26%. A report bases analysis was submitted by Central Road Research Institute, India where the laboratory tests were conducted in three types of soil- Marine Clay, Cuddalore soil and Pondicherry Soil treated with liquid bio-enzyme. The findings were that the compressive strength increased by 104% when treated with bio-enzyme for 4 weeks.

### Mechanism of Bio-enzymes

Enzymes are the complex peptides which act as a catalyst. These enzymes are produced by microorganisms to digest the biological soils. A bio-enzyme requires an hour to longer to initiate the process [13].

TerraZyme is a action- reactive compound forming an oily coating over the surface of soil and clay particles. It is directly proportional to the ion mobility and ion exchange. The water absorption is eliminated as the material becomes hydrophobic.

TerraZyme undergoes a reaction with soaked layer of water in the clay particles which results in the scaling down of thickness enclosing the speck of the soil. Therefore, there are no voids left between the particles of the soil adding on to the closer orientation with low compaction. Thereby, reducing the permeability and swelling capacity of the soil.

### Benefits of TerraZyme

An organic liquid formulated from the vegetable extracts. Above 55 degrees centigrade this bio-enzyme is known to lose its qualities. The plant-based solution is well constructed, and rate of decomposition is very low. The aromatic characteristics have no harmful effects and dilution with water before its application is crucial [15].

When TerraZyme is added into the soil its strength and stiffness increases. It is cost effective and gets decreased by 30 to 50%. It cuts down the plastic like properties of the soil. TerraZyme is known to improve the load bearing capacity of soil.

It facilitates increased soil compaction densities and replaces soiling of conventional road structures [14]. This bio-enzyme can be utilised to make highways, rural roads, airport runways and parking lots. TerraZyme delivers: -

- The strength to roads structure
- Reduces the cost of transportation and purchasing by reusing the in-site materials, upgrading, and improving the local soil quality.
- Construction savings can be reduced up to 10% to 25%.
- TerraZyme fixes the cracking and loosening of the soil.

- Recycling and reducing asphalt are known to increase the stability of asphalt by strengthening it two to three times.

## Conclusion

The results from the study indicated that bio-enzymes have a significant impact on the quality of soil. Improving its engineering and structural properties of soil. Harnessing bio-enzymes for soil stabilization and exploring the efficacy of soil stabilization examines and reviews the comparative study between the conventional methods and non-conventional methods of improving the quality of soil. Bio-enzymes being non-toxic and natural cleaners.

Considering the environment using bio-enzymes and preparing them at home can be a bigger step over switching from chemical based methods to bio-degradable and non-toxic methods. It is an organic solution and can be extracted from the regular household kitchen waste without causing pollution.

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