

# Non-conventional soil stabilization techniques The way forward to an aggregate free pavement And a Cost effective method of Road Construction

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**Abstract**—The decreasing availability of resources and the increasing cost of construction materials and uncertain economic climates has forced engineers to consider more economical methods for building roads. An obvious solution is to use locally available materials. As the road development projects are an integral part of a Country's economic growth, costing almost 50% of the Country's total investment in Infrastructure, a very careful evaluation of the alternatives is required which may prove to be beneficial to the economy.

However often, the alternate materials fall outside of required specifications. This situation becomes even more critical when an increasing demand for roads in underdeveloped rural areas. Likewise, there are increasing pressures on the mining, forestry and agricultural industries to minimize the production costs of their roads while delivering optimum performance and low maintenance costs. An economically feasible solution for achieving these objectives is the use of enzyme soil stabilization.

**Index Terms**— Soil Stabilization, Terrazyme, low cost, economics, pavement, conventional design, aggregate free.

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## 1 INTRODUCTION

Terrazyme is an effective and non-corrosive liquid enzyme that extensively enhances the properties of the soil used for construction of roads. It is a surfactant and its application assists in the expulsion of water from soils, and also helps in the lubrication of soil particles and increases the compatibility of many kinds of soils. Its reaction with many of these materials is particularly useful because of the ion-exchange capacity of clay minerals. TerraZyme can be used for various types of soil ranging from black cotton soils to hard murrum soils. It can be used for all those types of soil which has a minimum 10% of clay particles. TerraZyme is generally used for treatment of soils having Plasticity index in the range of 6.25 to 7.25. Soils after being treated with TerraZyme start behaving like a semi rigid pavement structure with much reduced permeability (1). Terrazyme is also designed to improve soil strength by increasing the density of the initial compaction and facilitating the removal of pore water, which helps in minimizing the destructive impact of water under load.

## 2. Working mechanisms of terrazyme

The soil considered in these studies are mainly gravelly clay, silty clay, clayey sand, medium to fine sand-clay mixtures, silt and clay mix etc. It has been proved that there is an increase in CBR value of more than 100% and Relative compaction by almost 100%. The clay minerals have a predominately positive ionic charge this causes clay minerals to have a strong attraction for any cations present in the material (2). Cations are attracted to the positive clay minerals. Nominal temperatures will not remove them. This layer of water is known as the electrostatic diffused double layer system. The large cations, such as sodium or water, cannot fit easily into these sites and get replaced. Small cations, on the other hand, fit firmly into these

vacated sites and cannot be removed. We thus have a situation in which the clay's negative charge is balanced and positive ions cannot be removed, thus rendering the clay inert to water. Terrazyme which is a cations-reactive synthetic compound forms a protective coating of an oily clay layer on the surfaces of soil and clay particles this reduces the ion mobility and ion exchange and thereby makes the material hydrophobic by eliminating the absorption of water. The result so obtained is a soil material which is much less sensitive to moisture, more workable and it can be easily compacted to a better particle-interlock state by simple equipment and traffic forces. Better particle interlocking means higher internal friction and thus an improved bearing capacity of the resultant soil. It also means greater density and less penetration of water into the soil thus reducing the maintenance required. The soil mass is now a permanently stable, Water Repellent Road Surface similar to that of a rigid pavements made of Concrete but with better properties.

## 3. Utilization & application in India

In India many trial roads have been built with Terrazyme in order to construct a stabilized road structure, like in Kerala, Pondicherry, Trindivanam and Tamil Nadu and all of these projects this method has proved to be beneficial. Also many Municipality roads in many states have adopted the use of terrazyme, like the Public Works Department of Maharashtra revealed that the use of Terrazyme resulted in overall cost savings in the range of 18-26% (3). Also many roads in Bangalore have also adopted this technique which have led to a three time faster execution and also 25-30% cost saving as compared to conventional construction.

**4. Application Procedure**

Application steps	Equipment required for successful application of TerraZyme
1) Scarify the soil to the required depth and width as per project specifications then Remove large stones, roots and trash etc from the loosened soil.	A scarifier mounted at the rear end is the best for this.
2) Pulverize the scarified soil till the soil mass is broken down completely and homogenous.	Farm tractor with roto-tiller and a pulverizer or any other mixing equipment.
3) Then Spray the solution (water +TZ) uniformly over the pulverized soil. The water to be added should be as be manufacturer's specifications.	Water truck with a distributor bar nozzle mounted on the front or back, a pump with a motor for suction purpose and to distribute the solution under pressure and a Tank volume of be 7000 to 12000 liters.
4) Mix the soil wetted with the solution of water + TerraZyme to the full depth scarified. Continue the mixing until uniform color is achieved.	Farm tractor with roto-tiller, pulverizer or other mixing equipment, such as discs, etc.
5) Compact the treated soil layer to the full density specified and full depth. Maximum depth for each treated layer should not exceed 20 cm.This minimum depth shall be maintained.	A `sheep foot roller compactor of more than 12 tons.
6) Shape the surface of the treated layer to meet design requirements for drainage and slope.(4)	Road grader with blade adjustment for pitch, angle and side to side elevation.
7) Finish the surface of the treated layer using the appropriate equipment and technique. Leave the smooth surface and free from holes, gouges, ridges or depressions in order to promote complete drainage.	12 ton self-propelled smooth roller compactor. A rubber tired compactor for soils of high plasticity.

**Loosen soil with a Grader or Pulverizer.**



**Mix treated soil to uniformity**



**Humidify soil using TerraZyme mixed with water**



## 5. Economic analysis

### A. CONVENTIONAL DESIGN

#### 5.1 Flexible Pavement (As per SP: 20-2001)

Flexible Pavements (All amounts in INR)			
Cross Section	Thickness mm	Rate/m <sup>3</sup>	Amount/m <sup>2</sup>
WBM Grade II	75	1000.00	Rs 75
WBM Grade II	75	1200.00	Rs 90
GSB Base	250	600.00	Rs 300
PC	230	600.00	Rs 138
PC	20	LS	Rs 90
Total			Rs 693

#### 5.2 Rigid Pavement (As per SP 62-2004)

Rigid Pavements (All amounts in Rs)			
Cross Section	Thickness mm	Rate/m <sup>3</sup>	Amount/m <sup>2</sup>
GSB	100	600.00	Rs 120
PQC(M25)	180	300.00	Rs 600
Base	230	600.00	Rs 138
Total			Rs 858

### TERRAZYME DESIGN

#### 5.3 Pavements designed using Terrazyme (ISO-9002)

Pavements designed using Terrazyme (All amounts in Rs)			
Cross Section	Thickness mm	Rate/m <sup>3</sup>	Amount/m <sup>2</sup>
Base	230	600.00	Rs 138
Terrazyme treated soil layers (2 layers) The top has 125mm 20% by volume down metal	125*2	LS	Rs 240
Total			Rs 378

## 6. CONCLUSION

After carrying out a detailed study, analysis and calculation carried out on the use of terrazyme as a soil stabilizer, the author would like to highlight the following findings

### 1. Savings & economic benefits.

The above analysis shows that as compared to the conventional flexible or rigid design of pavements the per sqm cost of terrazyme stabilized pavements is less, leading to a cost saving of 45.4% as compared to flexible pavements and 55.9% as compared to that of rigid pavements.

### 2. Fast return on investment

Rapid construction speed and associated lower costs of materials mean that the projects executed with Terrazyme deliver a much quicker return on investment as the time taken to construct conventional roads as the roads using TerraZyme becomes functional much faster and the Road contract starts getting the returns at a much earlier date as compared to conventional techniques.. The use of Terrazyme can lower a road's overall construction cost by 10% to 25%. AASHTO cost design models are used to show expected savings in comparison to standard project designs.

### 3. Higher production efficiency and output

Terrazyme has an easy application procedure as already explained and with the use of standard road construction equipments only an output of 3,000 square meters per day can be easily achieved.

### 4. Greater control over project quality.

Terrazyme soil stabilizer offers helps to increase layer strengths and thickness with the use of local soils and within the required cost of construction. The quality of road structures built with Terrazyme can be far superior to those constructed with conventional methods even when using local materials that do not meet normal load building specifications. Where local soil are sub-standard, and even with stabilization cannot meet design specifications, Nature Plus engineers can assist in soil blending options, which upon stabilization will achieve desired specifications

### 5. Reduced maintenance responsibilities

Terrazyme increases the flexural strength of the road base or sub-base course in order to reduce movement from vehicle loading on surface pavements such as asphalt or concrete. The result is that fewer potholes and ruts are identified on unsurfaced roads and less cracking and loosening of surface tack coating than that for unstabilized conventional structures..

### 6. Increase in CBR% and Flexural strength

Terrazyme improves the load bearing capacity of soil. Roads constructed using Terrazyme design concepts often reach a CBR (California Bearing Ratio) value of 90% or more in the base or sub-base layer as compared to 50% or less in an untreated structure. This improvement in flexural strength ensures a longer economic life for flexible pavements placed on roads built with Terrazyme. The result is fewer potholes and ruts on unsurfaced roads and less cracking and surface loosening on roads with a surfaced coating

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