



# LABORATORY INVESTIGATION OF DIFFERENT ADDITIVES TO CHARACTERIZE THE PERFORMANCE OF SUB-BASE SOIL” - A REVIEW

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**Abstract:** The aim of this paper is to examine the effect of some non-conventional additives on the properties of soil. In this paper, an attempt has been made to study the compaction and CBR characteristics tests of locally available soil mixing with different percentages (added individually and in combinations) of Silica Fume, Terrasil and Zycobond with a view to determine the optimum percentage. The current research shows the effective utilization of micro silica fume terrasil and zycobond in the improvement of sub grade characteristics of expansive soil. This paper deals with the review of some previous studies that are done to improve properties of weak soil by Micro silica, Terrasil and Zycobond.

**Keywords—** Soil Stabilization, Nano Silica Fume, Terrasil, Zycobond, CBR.

## I. INTRODUCTION

Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation has several modes like road, rail, air, water, ropeways etc. but it is the road network that is directly linked to users because for accessing any transportation mode, users have to use the roads first from the very beginning of their journey. Any inadequacy in road network affects the economical, industrial, social and cultural activity of a region. Soil stabilization in a broad sense includes various methods used for modifying the properties of soil to enhance its engineering performance. By stabilization the major properties of soil, i.e., volume stability, strength, compressibility, permeability, durability and dust control is improved, which makes the soil suitable for use. There are different methods of stabilization, which include physical, chemical and polymer methods of stabilization.

Nano chemicals (terrasil and zycobond) can be used to treat soils in order to improve their workability and load bearing characteristics in a number of situations. Nano chemicals (terrasil and zycobond) can substantially increase the stability, impermeability, and load bearing capacity of the subgrade. Application of nano chemicals (terrasil and zycobond) to subgrades can provide significantly improved engineering properties. Terrasil is water soluble, easy to apply nano chemical. It is a heat stable reactive soil modifier to stabilize the subgrade and made it waterproof. It eliminates capillary rise and water ingress from the top, it also reduces water permeability of soil bases and reduces expansivity and free swell. Terrasil also retains the strength of road bases and increases resistance to deformation by maintaining frictional values between silt, sand, clay particles. It also controls erosion of soil inside shoulders and slopes. Silica fume, also known as microsilica, is a byproduct of the reduction of high purity quartz with coal in electric furnaces in the production of silicon and ferrosilicon alloys. It is also collected as a byproduct in the production of other silicon alloys such as ferrochromium, ferromanganese, ferromagnesium, and calcium silicon.

Terrasil which has been selected for the present study is a nano Technology based product. It forms Si-O-Si bonded nanosiliconize surfaces in soil by converting water loving Silanol groups to water repellent Alkyl Siloxane groups. Terrasil is water soluble, ultra violet and heat stable, reactive soil modifier. It improves the frictional value, reduces water permeability and maintains breathability of the soil layer. Terrasil nanochemical is environmental friendly as it allows the use of in situ soil and conserves limiting resources like aggregates and bitumen. Zycobond is the commercially available chemical, used in the present study concludes that it is a potential stabilizer for locally available soils. Zycobond is acrylic co-polymer dispersion for bonding soil particles and imparting resistance to soil erosion and dust controls. It is mixed with Terrasil solution and sprayed on compacted soils. Soil properties of this region are characterized by high swelling and shrinkage associated with climate change in moisture content, low bearing strength etc. Soil samples collected from this region was tested in the laboratory for the investigation of various engineering properties.

## II. OVERVIEW OF WORK

The research work 'Laboratory investigation of different additives to characterize the performance of sub base soil (Silica Fume, Terrasil and Zycobond)' aims at observing the changes in engineering and geotechnical properties of local soil when it was mixed with various artificial additives like Silica Fume and two nano - chemicals which is Terrasil and Zycobond. The purpose of this study is to know whether locally available materials can be used in soil stabilization.

The main objectives of the study are

- To collect various types of nano - chemicals and natural additives used for soil stabilization.
- To study and evaluate the strength development of treated locally available soil with various percentages of materials added.
- To improve strength of sub bases, bases and sometimes surface courses.
- To improve permeability characteristics.
- To facilitate compaction and increase load bearing capacity.
- To improve excessive swelling or shrinkage, high plasticity.
- To increase CBR value.
- Reduce crust thickness.
- To reduce the construction cost by making best use of locally available materials.

## III. LITERATURE REVIEW

**Ekrem Kalkan (2008)<sup>1</sup>**, studied about the influence of silica fume on the desiccation cracks of compacted clayey soils. The aim of this study is to examine the suitability of silica fume as a stabilization material to reduce the development of desiccation cracks in compacted clayey soils. The amounts of silica fume were selected to be 5%,10%,15%,20%,25%,30% and 50% of the total dry weight of the clay soil-silica fume mixtures. Natural clayey soil and clayey soil-silica fume mixtures were compacted at the optimum moisture content and subjected to laboratory tests. In each sample, it was observed that reduction in the development of desiccation cracks occurred with increasing silica fume content between 0 and 25%. The results show that silica fume decreases the development of desiccation cracks on the surface of compacted samples. It is concluded that silica fume waste material can be successfully used to reduce the development of desiccation cracks in compacted clayey soil.

**Rintu Johnson, Dr. Kodi Rangaswamy (2015)<sup>2</sup>**, The soil was collected from Kunnamangalam area of Calicut district in Kerala and the Terrasil Nano-chemical was collected from Zydex, Industries Ltd. for the stabilisation studies. Experimental programme was carried out on both clay and cement treated clay treated with different dosages of Terrasil. Specimens were prepared with 0.05%, 0.07% and 0.09% Terrasil and 1% cement by weight of soil. Results obtained were compared and studied. The CBR strength of soil mixed with optimum dosage of 0.07% terrasil chemical is improved about 6 times the CBR strength of clay soil. The treated soil was found to be impermeable.

**Nandan A Patel, Prof. C. B. Mishra, Vasu V Pancholi (2015)<sup>3</sup>**, in the paper highlighted that it is always best to make use of local soil available. This soil must be stabilized and the soil properties must be corrected using additives. It is the responsibility of the road authorities to utilize the available soil and modify it as per design requirements. The investigation focused on the soil engineering properties (with and without stabilizer), standard compaction; soaked for 4 days, California Bearing Ratio (CBR),

permeability test and cyclic loading test. Terrasil was utilized as a stabilizer and it was utilized for altered measurement, i.e. 0.041% by dry aggregate weight of soil test. Test results indicated that geotechnical properties got modified and CBR on stabilized clayey samples increased substantially.

**Roopika Srivastava, Prachi Kushwaha, Dr. B. L. Swami, (2016)<sup>4</sup>**, in their paper laboratory test results indicated that the type of soil greatly influences the performance of these nanochemical stabilizers. Addition of nanochemical and cement improved CBR and UCS. It is also noted that increment in dosages rate resulted in a decrement in the consistency limits. Thus, making it clear that soil stiffening is one of the effects of using the chemical. It makes the soil completely impermeable.

**Mrudul U V, Prof. S. M. Damdariya, Prof. N. B. Parmar (2016)<sup>5</sup>**, In this paper present that investigation of black cotton soil treated with terrasil and cement. In this study soil with variable dosages were tested for stabilization process and strength of the stabilized soil has been evaluated after curing period. This tests were carried out to determine the consistency limits, CBR value of soil specimens with and without stabilizers for curing period. By this test result maximum dry density of soil decreased with the addition of cement and value of optimum moisture content of cement treated soil increased. By taking values percentage of lime and terrasil i.e. (1% , 2%)lime and (0.02% ,0.04%)terrasil. from this CBR values of soil increased from 2.58 to 29.34 from combination of soil + 1% cement + 0.04% Terrasil in this paper. By CBR value thickness of pavement reduced and cost is reduced.

**Ajay Kumar Pandagre & Ashutosh Rawat- (2016)<sup>6</sup>**, in improvement of soil properties using non chemical terrasil. Calcium chloride being hygroscopic and deliquescent is used as a water retentive additive in mechanically stabilized soil bases and surfacing. Sodium chloride is the other chemical that can be used for this purpose with a stabilizing action similar to that of calcium chloride. Sodium silicate is yet another chemical used for this purpose in combination with other chemicals such as calcium chloride, polymers, chrome lignin, alkyl chlorosilanes, siliconites, amines and quarternary ammonium salts, sodium hexametaphosphate, phosphoric acid combined with a wetting agent. Now a day's nano chemicals are widely used for improving the properties of soil, some nano chemicals are terrasil, zycobond, etc.

**Rajshekhar G Rathod (2017)<sup>7</sup>**, also discusses the use of Terrasil and its benefits in his paper. It was concluded from the tests carried out in the laboratory that chemical stabilization had more CBR value than the conventional method of soil stabilization. Chemically stabilized soil required a lesser thickness of sub-grade in comparison with conventional stabilization. By adding Terrasil plasticity index reduced and dry density increases. Chemical stabilization using Terrasil is economical compared to other conventional methods.

#### IV. NEED FOR THE PROPOSED WORK

- Improve CBR value.
- Improve permeability.
- Improve swelling and shrinkage.
- Improve strength of sub-base.
- Reduce the thickness of pavement.

#### V. OBJECTIVE OF THE WORK

The salient objectives of the study have been identified as follows:

- To improve strength of sub bases, bases and sometimes surface courses.
- To improve permeability characteristics.
- To facilitate compaction and increase load bearing capacity.
- To improve excessive swelling or shrinkage, high plasticity.
- To increase CBR value.
- Reduce crust thickness.
- To reduce the construction cost by making best use of locally available materials.

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