

Sub-Grade Stabilisation using Nano Particles

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Abstract- Soil stabilization is a process to improvise the engineering properties of soil to resist heavy loads due to moving vehicles. The structural performance of the subsequent layers has proven questionable with time as the water still tends to recede down the pavement surface to the sub-grade. The study of these characteristics and the performance check of pavements with the evaluation of subgrade strength is done by adding Nanoparticles stabilizers like Terrasil and Zycobond. Vehicles tend to increase day by day and the pavement is laid on every kind of soil, including soft soils. Soil stabilization is usually done by the locally available materials but at some places where local material is not available, it might increase the cost of construction. To replace the locally available material and increase the strength and load-carrying capacity, stabilizers such as Terrasil and Zycobond based on nanotechnology manufactured by Zydex industry in Gujrat are used. Nanomaterials are the materials having less than 100nm dimensions. These are the chemical additives injected to the soil helping in binding the soil particles, reduce swelling and increases CBR value. This paper deals with the review of some previous papers that are done to improve the properties of weak soil by using Nanoparticles.

Keywords: Soil Stabilization, Subgrade, Terrasil, Zycobond, Strength., CBR

1. INTRODUCTION:

India has one of the largest road networks across the world panning over 5.5 million km, with the robust monsoon that damages the roads and making the sub-grade poor that does not resist the load. Strength is one of the main parameters for the construction of roads. Rain decreases the strength, durability and load-carrying capacity of the subgrade. For Black cotton soil, these climatic changes are responsible for shrinking and swelling.

Soil stabilization plays a vital role in the construction of pavements on the soft sub-grade to increase the engineering properties of soil. For stabilization of sub-grade different methods are used such as thermal stabilization, electrical stabilization, chemical stabilization, and mechanical stabilization. Thermal and Chemical Stabilization is used in some cases but not in common use. Chemical stabilization is the process in which chemicals are injected into the soil in such a way that it increases the strength, durability, swelling and load-bearing capacity of soil for the construction of the pavement. Different chemicals are used for stabilization of sub-grade such as Terrasil, Zycobond, etc.

Nano-particles are minute/fine particles having a range between 1 and 100 nanometres (nm) in size with a surrounding boundary between two portions of matter. The boundary layer is an essential part of the nano-scale that affects the whole property of matter. The boundary layer mainly consists of different molecules such as ions, organic and inorganic. The Organic molecules provide a coating to inorganic nanoparticles which are called stabilizers, capping and covering agents.

Nano chemicals like Terrasil and Zycobond are nanotechnology-based products that help in binding soil particles together for better compaction. Terrasil is a waterproof agent and Zycobond is a bonding material that is introduced by the Zydex Industries. Nanoparticles as an outer factor to the soil will help in changing soil behavior at the atomic or molecular level and it increases the strength, reduces permeability and decreases the affecting properties of soil.

Terrasil:

Terrasil is a solution in the form of liquid produced by Zydex industries in Gujarat. Terrasil is water-soluble, UV and heat-stable to reduce swelling. Terrasil is a waterproof agent that helps in compacting the soil up to 10 mm depth. Terrasil

converts the water-absorbing silonal group to a water-resistant alkyl siloxane surface at ambient temperature. It provides shielding to the soil particles to reduce the repelling effect and provides better compaction.

Parameter	Value
Appearance	Pale Yellow
Solid content	68+2%
Viscosity at 25JC	20-100cps
Specific Gravity	1.01
Solubility	Forms water clear solution
Flash point	Flammable 12JC
Dosage	1%per m ³

Table 1: Characteristics of Terrasil

Table 2: Chemical composition of Terrasil

Chemical compound	Value in range, %
Hydroxyalkyl-alkoxy-alkylsilyl	65 – 70 %
Benzyl alcohol	25 – 27 %
Ethylene glycol	3 – 5 %

Zycobond:

Zycobond is a UV and heats stable, cross-linked soil modifier. The nano-sized polymer is depressed in water it stabilizes the soil by imparts water-resistant and flexible bonding to the soil. Zycobond is a nano polymer particle size of about 90nm and the dosage is per m³ contains the same number of polymer particles as compared to soil.

Table 3: Technical speciation of Zycobond

Parameter	Value
Colour	Milky white
Odour	No
Flash point	Above 100°C
Explosion hazard	No
Ignition temperature	Above 200°C
Solubility in water	Dispersible
pH value	5-6

2. Literature Review

Ajay Kumar Pandagr et al (2017). The soil also with 2% lime mixture added with 0.07% Terrasil is the best soil combination which is exhibiting the higher UCC strength and CBR value.

The stabilized soil of soil-lime-terrasil mixture is very useful as a sub-grade material due to improved CBR value to reduce the thickness of overlying base-course layers in road pavement.

Chaudhari Riddhi, Tabiyar Suman et al. (2016) The experimental study is done for stabilization of Soil mixed with 0.041% solution. The result shows that Terrasil is most economical as well as beneficial for stabilization purposes, also load

carrying capacity is increased. Terrasil should be used for stabilization purposes in road construction it will help in decreases the thickness of the pavement layer that will reduce the cost of construction.

Dr.V.Giridh (2016) The study shows that Plastic limit decreases with an increase in various percentages of Zycobond. Plasticity index decreases with an increase in the percentage of Zycobond. California bearing ratio increases with an increase in various percentages of Zycobond. There is a rapid increase in CBR value. Shear Strength increases with an increase in various percentages of Zycobond.

Dr.R.Srinivasa Kuma et al.(2018) For the clay used in this study there was an increase of 57.21% in the CBR value for the unsoaked condition when it is stabilized with Terrasil and Zycobond. For the clay used in the present study, there was a drop of 19.62 % in the CBR value when it was soaked for four days.

Seyedi Gelsefidi Seyed Alirez et al (2013) gives an experiential study on soil. The optimum amount of lime is 5% when mixed with soil obtains the highest CBR strength value. when the addition of nano-silica is mixed in the mixture (soil-lime) that causes a decrease in the Maximum Dry Density and increases the optimum moisture content of the soil.

V. Subraman and S.Sridev (2016) The experimental study is done on the peat soil in which various amounts of nanoparticles are added to find the compaction characteristics and compressive strength. Firstly soil is mixed with 2% of Nano cement, 2% of Nano clay and after that addition of 1% of Nano cement and 1% of Nano clay is mixed with the mixture that gives maximum strength in the combination of 1 % of Nano cement and 1% of Nano clay. The whole mixture gives the maximum strength that can be attained by adding both the admixtures Nano cement and Nano clay.

Lekha B.M, et al. (2013) The experimental study is done on black cotton soil in which the behavior of Black Cotton (BC) soil is found in virgin soil and then chemical stabilizer. Terrasil was used as a stabilizing agent. Terrasil is mixed with soil in different proportions and cured for 7, 14 and 28 days. The Terrasil reacts with the soil by chemical reaction results reduces the voids between soil particles and makes the soil impermeable and decreases permeability. The X-Ray Diffraction (XRD) and Scanning Electron Microscope (SEM) respectively help to analyze the chemical composition and microstructure of soil.

3. Conclusion:

From this study, it is clear that for the stabilization of subgrade, with the help of Terrasil and Zycobond, the structural properties of soil without using any locally available materials are improved. Terrasil and Zycobond mixes with water and sprays on the sub-grade which helps in compacting the soil particles together up to 200mm. It reduces the shrinkage and swelling and also makes the soil water-hating to water-loving. Terrasil and Zycobond make a thin waterproof layer that reduces permeability to the tune of 10-7 to 10-8 cm/sec up to depth if 10mm if some water enters the soil base it eventually evaporates and escapes through the breathable waterproof layer. This prevents capillary rise at the base and water ingress at the top and helps the soil dry throughout the season. It is found that the California bearing ratio (CBR) and UCS increase when soil is mixed with the specific nanoparticles. With the increase in dosage, the values also increased. These chemicals increase the strength, load-bearing capacity, and durability of the subgrade so that maximum load caused by the traffic can resist without any failure in the pavement and improves the life span of the road as well as reduces the thick layer of the pavement to decrease the cost of construction.

References:

[1] V. Subremani,S.Sredevi,"Soil Stablization using Nanomaterials International Journal for Research in Applied Science and Engineering Technology(IJRASET) ISSN:2321-9653 Volume:04 issue March 2016.

- [2] Nandan A. Patel, C. B. Mishra, Saurabh B. Gautam "Influence Of Chemical Additive In Modification Of Subgrade Soil For Pavements" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 9, September 2015.
- [3] Chaudhari Riddhi, Tabiyar Suman, Bholanda Heena, Chaudhari Shivani, C. B. Mishra International Journal of Research and Scientific Innovation ISSN 2321 – 2705 Volume III Issue V, May 2016 .
- [4] T.Raghavendra, B.Rohini, G.Divya, S. Abdul Sharooq, B.Kalyanbabu," Stablization of Black Cotton Soil using Terrasil and Zycobond" International Journal of Creative Research Thoughts ISSN: 2320-2882 issue: Feb 2018.
- [5] Mane S R Rohith, Dr.R.Srinivasa Kumar, William Paul, Nagilla KumaraSwam," A study on the effect of stabilizers (zycobond & terrasil) on strength of subgrade on bc soil" International Journal of Research and Scientific Innovation ISSN: 2250-0138 issue: 2018.
- [6] Olumuyiwa S. Aderinola, Emeka S. Nnochiri," Stabilizing Lateritic Soil Using Terrasil Solution" SSP - JOURNAL OF CIVIL ENGINEERING Vol:12, Issue 1, 2017.
- [7] S.Anwar Hussain," Soil Stabilization Using Nano-Materials for Rural Roads–A Case Study" International Journal of Innovative Research in Science, Engineering and Technology ISSN: 2347 - 6710 Volume 5, Special Issue 14, December 2016.
- [8] Dr.V.Giridhar, P.Suresh Praveen Kumar, S.Jyothirmayee," An Experimental Study on Strength Characteristics of Expansive Soil Treated with Zycobond" International Journal of Innovative Research in Science, Engineering and Technology ISSN: 2347-6710 Vol: 6, Issue:1, January 2017.
- [9] M. Anvesh kumar, Venkateswarlu.S, "Stabilization with nano materials and cement for improvement of soil properties for roads" International Journal of Engineering Research ISSN: 2321-7758 Vol:6.,Issue.4, 2018 July-Aug.
- [10] Roopika Srivastava, Prachi Kushwaha, Dr. B. L. Swami," Suitability of Nano-Chemical Stabilizer in Black Cotton Soil" International Journal of Civil and Structural Engineering ISSN 2372-3971 Volume 3 : Issue 3 December, 2016.
- [12] Mr. A. Ghosh, Mr. Rabindranath Ghosh, Mr. Love Gupta, Mr. Ankur Kumar, Mr. Irshad Ali, Mr. Prashant Chahal," A Review Paper on Stability of Soil Block using Bitumen Emulsion" International Research Journal of Engineering and Technology (IRJET) ISSN: 2395 -0056 Volume: 04 Issue: 04 Apr 2017.
- [13] Ajay Kumar Pandagre, Rajesh Jain," Effect of Terrasil on Geotechnical Properties of Expansive Soil Mixed With Lime" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653 Volume :5 Issue: I January 2017.