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[Kataria* *et al.*, 6(7): July, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

# IMPROVEMENT IN SUBGRADE SOIL BY ENVIROTAC II

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**DOI**: 10.5281/zenodo.834608

## ABSTRACT

The subgrade conditions which are poor can result in inadequate pavement support which may reduce pavement life. Soils may be improved by adding polymers, chemical or cementitious additives. Polymers are used worldwide for stabilization of soil. Polymer used are polyvinyl acetate, polyacrylamides and polybutadienes. These additives can be used with a variety of soils to help improve their native engineering properties. The effectiveness of these additives depends on the soil treated and the amount of additive used. Envirotac II consists of environmentally safe, high performance Vinylacatae co-polymer which works on the principles of nano-technnology .It was found that with the addition of stabilizers i.e. polymers and cement, the C.B.R. increased upto a certain limit but after that the C.B.R. decreased even on the further addition of stabilizers. The Envirotac II was added percentages ( 1%, 2%, 3%, 4% and 5%) to the subgade soil with clay and silt content 84% and sand content 16%, MDD(1910 Kg/m$^3$ ), OMC(13%) and CBR% (4.09). At optimum dose of 4% MDD(1994 Kg/m$^3$), OMC( 10.1%) and CBR % (21.90) were achieved. Thus there was a sharp increase in CBR upto 435 % at optimum dose of 4%. The same soil was treated with different %ages of cement (2%, 4%, 8%, 12% and 15%). For the dose of 15% cement MDD (2005 Kg/m$^3$ ), OMC(11.50) and CBR(7.90) were achieved. There was a gradualincreaseinCBRupto 93.15 % at 15% addition of cement. Thus Envirotac II can stabilize the subgrade soil with much more with less dose as compared to cementitious additives.

**KEYWORDS**: Subgrade Soil, Optimum Dose, California Bearing Ratio, Polymers.

## I. INTRODUCTION

Subgrade layer is lowest layer in the pavement structure underlying base course or surface course depending on the type of pavement. The subgrade mostly consists of various soil materials which are locally available and due to softness and wet conditions, may be unable to support pavement loading. Before the construction of the pavement one must understand the prevailing in-situ conditions of subgrade soil .There will be better durability of the pavement if strength/stiffness quality of the materials is good. Hence, the pavement design must based on the accurate use, less costlier, and subgrade materials to get their best performance. When wet and soft subgradeexists, they must be given treatment to get subgrade workable for upper layers for pavement construction. Stabilization of Subgrade soil is economical because materials provided for roadconstruction is relatively cheaper. Available materials at site may be used. Stabilization can be done by various techniques. Various types of polymers were used for stabilization. Polymers stabilize the soil by forming complex bonds by the process of nano-technologyamong the aggregates. The soils which have very low load bearing capacity may be used for construction of pavements under roads where there is very heavy traffic at low cost as compared to asphalt construction. Portland cement can be used for stabilizing soil. The reaction of water soil and cement results the generation of material which is responsible for stabilization of soil.In the process of stabilization of soil engineering properties are improved which results into more stability of soil. Stabilization is done when the soil at construction site has not required load bearing capacity. The processes involved in the stabilization may be preconsolidation, compaction and drainage. In the process of stabilization finer soil particles are binded to form new compounds. Therefore one must know the stabilization process used in each stabilizer when selection of stabilizer is to be done.

## II. OBJECTIVES OF THE STUDY

1. To study the effect of Envirotac II on local soil.
2. 2. To find the optimum dose of Envirotac II for theimprovement of strength of the subgrade soil.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

3. To compare the stabilization with conventional methods of Ground stabilizationi.e with cement.

## III. MATERIALS USED

Envirotac IIis product of USA and it is soluble in water. It may be used for stabilization of soil as well as for dust abatement. Envirotac II stabilizes soil upto very high extent, it is a environment friendly product, it is safe to use and its cost is low. While its application to soil it penetrates into the soil and hold surface. Upon drying, the surface formed is water proof and UV resistant, a solid bond is formed which holds the particles of soil together. When percentage of Envirotac II is increased the surface becomes more durable and surface becomes so hard that it can bear heavy traffic. Polymers stabilize the soil by forming complex bonds by the process of nano-technologyamong the aggregates. By using Envirotac II the soils which have very low load bearing capacity may be used for construction of pavements under roads where there is very heavy traffic at low cost as compared to asphalt construction. Envirotac II maybe used for Green Roads. It has no adverse effect on the health of human beings. When road is constructed where Envirotac II is used, there is very less substances which pollutes air as compared to road where asphalt is used. This product can be used for hydroseeding and it is also safe in this case. Polymers stabilize the soil by forming complex bonds by the process of nano-technologyamong the aggregates. It can also be used for control of erosion, suppression of dust, stabilization in case of embankment. Because of its capability of being water proof it may be used as ponds liners.Envirotac II is used in liquid form for stabilization of soil and it is biodegradable, it keeps seed safe from blowing wind and from erosion caused by water. In the USA and many countries of world it is used as erosion control. During the application of polyvinyl acetate a three dimensional membrane is formed which is that keeps soil and seed at their place, the oxygen and water are allowed to penetrate. The Envirotac II can be used for all types of soil for their stabilization and also can be used forstabilizationof seedeven in remote area in terms of environment. Polyvinyl acetate can also be used for protection of slope. Polyvinyl acetate in its liquid form gives strength the soil surface. A three-dimensional structure is generated in upper few cmsof the soil which gives excellent results. The seeds are binded to soil particles and germination is promoted.During its application oxygen and rain can penetrate into its surface, The dehydration in case of plants and soil is not possible because of longer stay of water.Envirotac II can be used for stabilization of soil where surfce is flat as well in case of steep slopes. Its cost is low, normal spray method can be used for its application, thus not much labour is required for its application at site. This product is available in liquid form in the market and for hydoseeding it can be mixed into the tank along with water, fertilizer and seed etc. The labour required is very less for its application. Spraying may be used for its application. The equipment used for its application at site can be easily washed with water. The compressive strength in case of Envirotac II is much more as compared to when lime or cement is used for stabilization of fine grained soils.

In case of Portland Cement, cementitious products are formed when the hydration takes place between calcium aluminates and calcium silicates of cement. There is immediate strength gain of stabilized layers in case of cement due to fast hydration. There must not be mellowing period givenin between compaction and mixing the ingredients i.e. soil, water and cement. The compaction of soil after mixing cement must be done usually within 2 hours before or after initial setting. The required density may not be developed by traditional compaction energy within this period unless compaction is achieved. The cement is being used for various situations having 2-4 hrs mellowing periods or even more than it. Mostly, the remixing of soil is done if mellowing periods is over for getting a mixture which is homogeneous before compaction. If compaction is done before initial settingthe ultimate strength of a soil cement product will not be lower even if withextended mellowing period, Because of improved uniformity due to remixing the ultimatestrength achieved with passage of time in the soil when there is extended mellowing period is accepted.Normally it is recommended that compaction of soil cement must be done before 2 hours of their mixing. The Ca (OH) which is called free lime is formed by the hydration process. When cement and water are mixed, 25% is the lime by weight. The free lime in situation of high value of pH has capability to have pozzolanically reaction with the soil, it looks similar that lime do the reaction remains in continuity upto limit the value of pH remains more than 10.5.The properties of soil are improved by addition of small percentages of cement in case of stabilization by cement. The percentage of cement required for stabilization of soil can vary from 3 - 16% by dry weight of soilit also depends upon type of soil used and properties which are to be achieved. The actual quantity of cement required for a particular soil is determined by laboratory tests. Many types of cement can be used for stabilization of soil but it is better to use OPC.

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**Treatment of weak subgrade**

Subgrade stability depends on strength of soil and how it behaves when loads are applied on it. There must not be rutting during construction of pavement also shoving must be avoided. It must provide better support when pavement layers are going to be laid. It must give better support when compaction of layers is going on. Subgrade must not have permanent deformation even after long times after passage of heavy loads.The failure in subgrade under flexible pavement may occur due to loads which are applied by vehicles running on roads. There is variation in load which acts on different layers of subgrade through the pavement. Due to this varying load and high moisture content, the failure in subgrade may occur which further may cause failure of pavement. The most of failures in pavement structure are caused due to failure of subgrade which are due to failure of bearing capacity. Subgrade soils of clayey soils may have high strength when moisture content is low. But after OMC the workability decreases and strength also decreases. Then there are two options whether to replace the existing soil or to stabilize it by adding different percentages of stabilizers. The replacement in many cases is not possible due non presence of required material or its cost is very high. In such cases Soils may be improved by adding polymers, chemical or cementitious products. Polymers are used worldwide for stabilization of soil. Polymers used are polyvinyl acetate, polyacrylamides and polybutadienes. The chemical stabilizers may include Portland cement, fly ash, lime and dust of cement kiln. The engineering properties may be improved by adding these stabilizers. The improvement in subgrade soil by adding these stabilizers depends upon amount added and type of soil treated. The Pavement life may be reduced due to poor subgrade conditions. It is not economical to replace the subgrade soil. Soils may be improved by adding Polymers, Enzymes, Geo-textiles cement, lime etc. The traffic loads are increasing day by day and pavement conditions are also affected by variation in environment conditions. So it is today's necessity to find out the way to improve the subgrade soil by method which is economical, durable and easy to apply and is environmentally friendly. Design of the various

| | | |
|---|---|---|
| 1 | Silt and clay | 84% |
| 2 | Sand | 16% |
| 3 | Classification | Fine Grained ML |
| 4 | L.L. | 24.50% |
| 5 | P.L. | 20.04% |
| 6 | P.I. | 4.46 |
| 7 | Sp. Gravity | 2.53 |
| 8 | MDD | 1910Kg/m$^3$ |
| 9 | OMC | 13% |
| 10 | CBR(%) | 4.09 |

pavement layers depends upon the subgrade strength on which pavement layers beinglaid. California Bearing Ratio (CBR) represents the strength of subgrade soil. There is change in pavement thickness with change in value of C.B.R. With higher value of C.B.R the pavement thickness is less and vice versa.Mixing cement with soil is a tough task. This can affect the performance of the pavement. Mixing in case of Polymer is simple being in liquid form. For spreading cement and mixing it with soil cement spreader and stabilizer machines are required, but in case of Polymer simple machine like grader or rotavator are required for mixing. Experimental study is required to know improvement in the subgrade soil by different types of stabilizers.

## IV. EXPERIMENTAL PROGRAMME

TheDesign of the various pavement layers depends upon the subgrade strength on which pavement layers beinglaid. California Bearing Ratio (CBR) represents the strength of subgrade soil. There is change in pavement thickness with change in value of C.B.R. With higher value of C.B.R the pavement thickness is less and vice versa.Mixing cement with soil is a tough task. This can affect the performance of the pavement. Mixing in case of Polymer is simple being in liquid form. For spreading cement and mixing it with soil cement spreader and stabilizer machines are required, but in case of Polymer simple machine like grader or rotavator are required for mixing. Experimental study is required to know improvement in the subgrade soil by different types of stabilizers. California bearing ratio test is meant for evaluation of strength of subgrade soil. After performance of this test the increase in strength of subgrade soil is studied. In this research we come to know the improvement of subgrade soil by adding various additives. The gain in strength of subgrade soil is evaluated by

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

adding different percentages of cement and Envirotac II. This study gives us idea to consider the better option for stabilization of subgrade soil. Durability of pavement will be better for good quality subgrade.

## V. ANALYSIS AND DISCUSSION OF RESULT

The various results were obtained by adding different percentages of Envirotac II and Cement. The %ages of Envirotac II added were 1%, 2%, 3%, 4% and 5%. The %ages of cement added were 2%, 4%, 8%, 12% and 15%. In case of Envirotac II MDD increases with increasing the percentages of Envirotac II but after optimum dose MDD decreases. The OMC decreases with increase in percentage of Envirotac II and after optimum dose it increases. The CBR value increases upto optimum dose and with further addition it decreases.The results of compaction test and CBR tests are shown by following figures

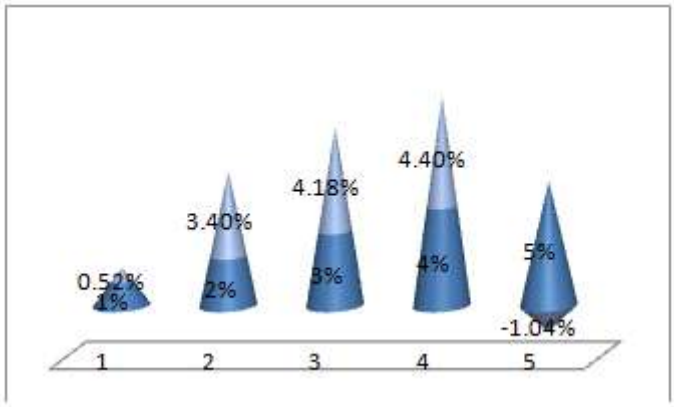


***Fig. 1 Variation of Maximum Dry Density (MDD) in comparison to base sample.***

The figure 1 shows the percentage increase of MDD by adding different percentages of Envirotac II to subgrade soil in comparison to base sample. It shows that maximum percentage increase of MDD is 4.40 at 4% addition of Envirotac II but after that it decreases when 5% Envirotac II is added

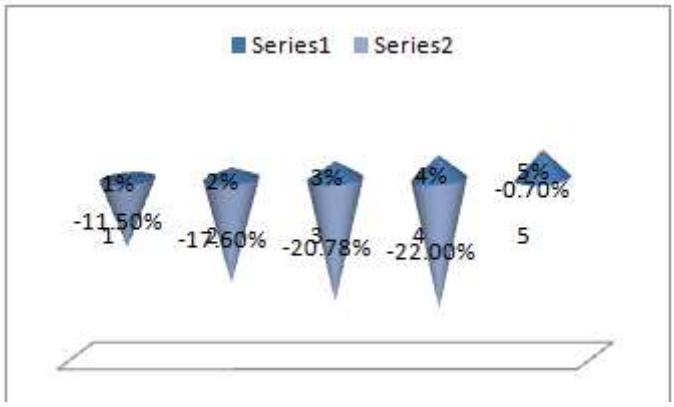


***Figure 2 Variation of Optimum Moisture Content (OMC) in comparison to base sample***

The figure 2.shows the percentage decrease of OMC by adding different percentages to subgrade soil in comparison to base sample. It shows that minimum percentage decrease of OMC is 22.0 at 4% addition of Envirotac II but after that it increases when 5% Envirotac II is added.

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Impact Factor: 4.116
CODEN: IJESS7

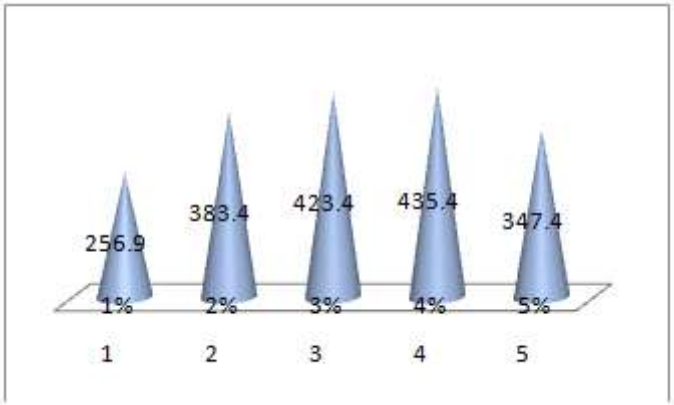


***Fig.3 Percentage Increase of California Bearing Ratio with Envirotac II***

The figure 3 shows the percentage increase of CBR by adding different percentages of Envirotac to subgrade soil in comparison to base sample It shows that maximum percentage increase of CBR(%) is 435.4 at 4% addition of Envirotac II but after that it decreases when 5% Envirotac II is added

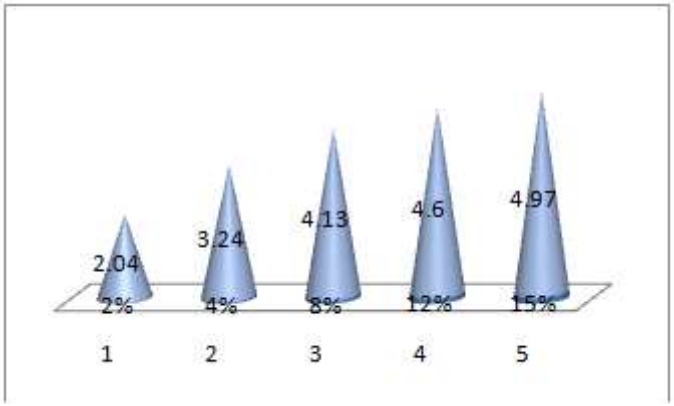


***Fig.4Variation of Maximum Dry Density (MDD) in comparison to base sample***

The figure 4 shows the percentage increase of MDD by adding different percentages of Cement to subgrade soil in comparison to base sample. It shows that maximum percentage increase of MDD is 4.97 at 15% addition of Cement

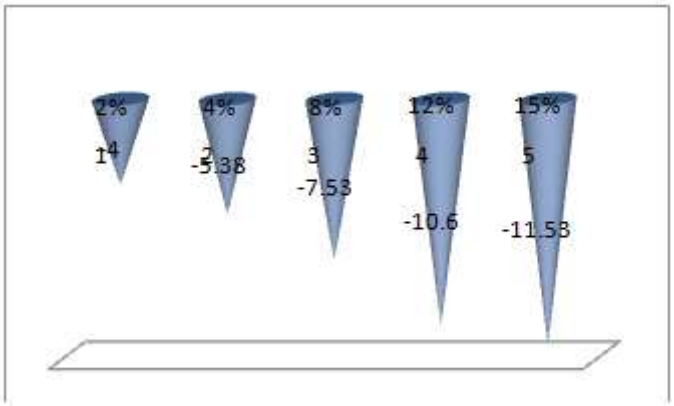


***Fig.5 Variation of Optimum Moisture Content (OMC) in comparison to base sample.***

The figure 5.shows the percentage decrease of OMC by adding different percentages of Cement to subgrade soil in comparison to base sample. It shows that maximum percentage decrease of OMC is 11.53 at 15% addition of Cement.

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Impact Factor: 4.116
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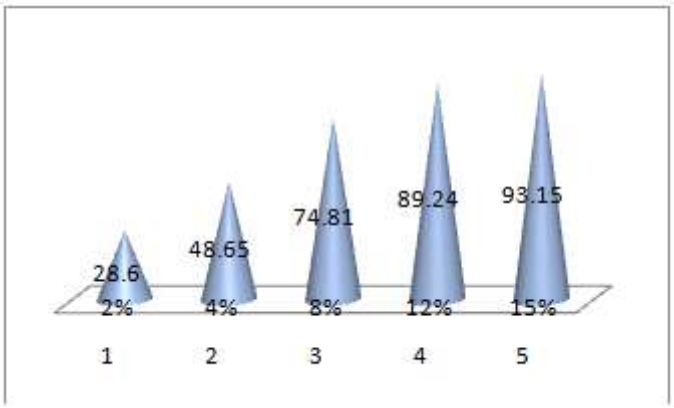


***Fig.6 Percentage Increase of California Bearing Ratio with Cement Content.***

The figure 6 shows the percentage increase of CBR by adding different percentages of Cement to subgrade soil in comparison to base sample. It shows that maximum percentage increase of CBR(%) is 93.15 at 15% addition of Cement.

The following figures shows the combined results of addition of Envirotac II and cement to subgrade soil.

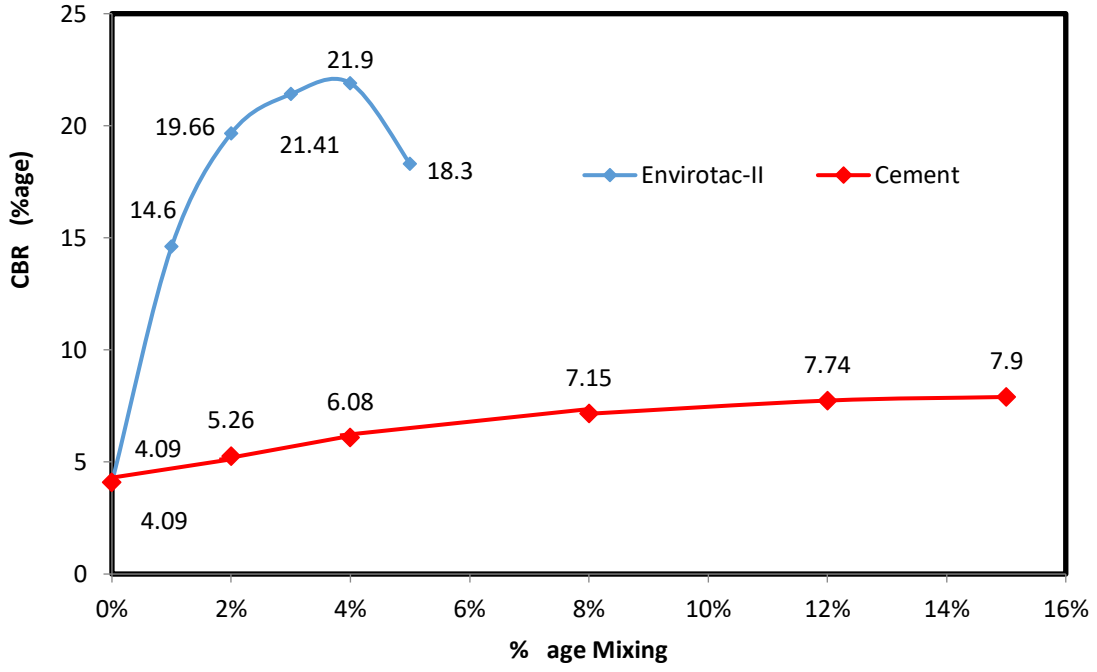


***Fig.7 Variation of MDD with Envirotac II and Cement***

The figure 4.23 shows variation of MDD of subgrade soil when different percentages of Envirotac II and Cement are added. It shows that MDD is increasing upto 4% addition of Envirotac II and reaches to maximum value of 1994 Kg/m$^3$ but after that it decreases when 5% Envirotac II is added and MDD is increasing upto 15% addition of Cement and reaches to maximum value of 2005 Kg/m$^{3.}$

ISSN: 2277-9655
Impact Factor: 4.116
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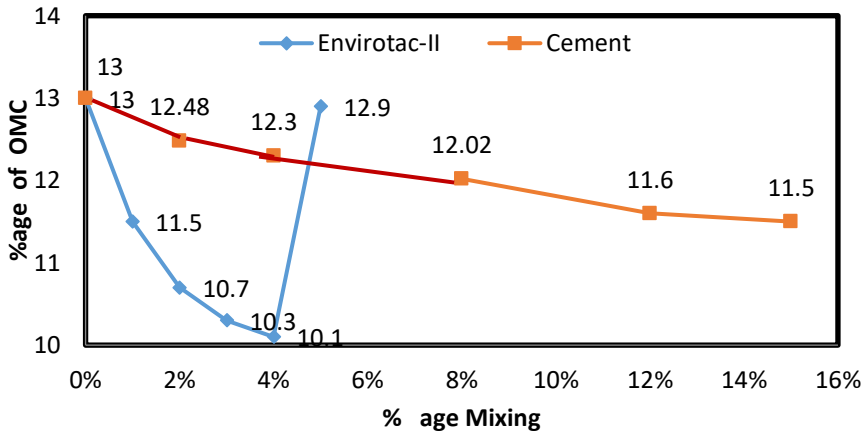


*Fig.8Variation of OMC with Envirotac II and Cement.*

The figure 8.shows variation of OMC of subgrade soil when different percentages of Envirotac II and Cement are added. It shows that OMC(%) is decreasing upto 4% addition ofEnvirotac II and reaches to minimum value of 10.1 but after that it increases when 5% Envirotac II is addedand OMC (%) is decreasing upto 15% addition of Cement and reaches to minimum value of 11.50.

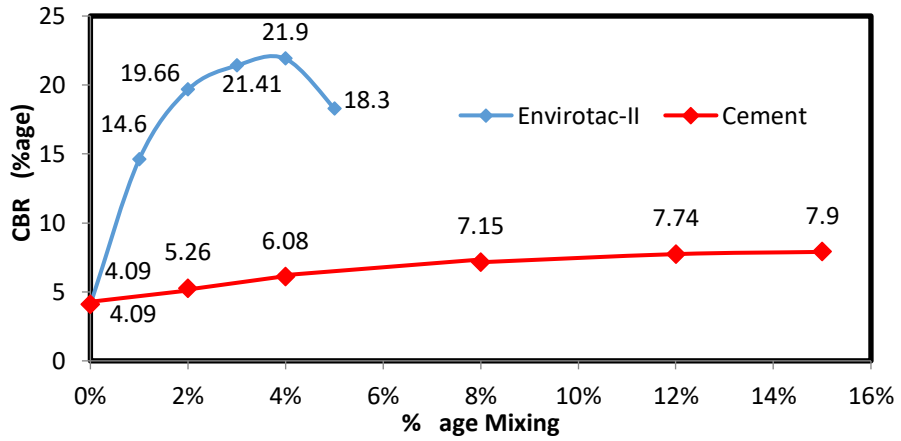


*Fig.9 Variation of C.B.R. with Envirotac II and Cement.*

Thus It was found that with the addition of stabilizers polymer, the C.B.R. increased upto a certain limit but after that the C.B.R. decreased even on the further addition of polymer. The Envirotac II was added percentages ( 1%, 2%, 3%, 4% and 5%) to the subgade soil with clay and silt content 84% and sand content 16%, MDD(1910 Kg/m$^3$), OMC(13%) and CBR(4.09). At optimum dose of 4% MDD (1994 Kg/m$^3$), OMC (10.1%) and CBR (21.90) were achieved. Thus there was a sharp increase in CBR upto 435 % at optimum dose of 4%. The same soil was treated with different %ages of cement (2%, 4%, 8%, 12% and 15%). There was a gradual increase in CBR upto 93 %at 15% addition of cement. Thus Envirotac II can stabilize the subgrade soil with much more with fewer doses as compared to cementitious additives

## VI. CONCLUSIONS

The major conclusions drawn at the end of the work are as:

1. In case of addition of Envirotac II, the C.B.R value increases upto 4% addition of Envirotac II and on further addition of Envirotac II the C.B.R value decreases. In case of addition of cement, the C.B.R value increases upto 15% addition of cement.
2. In case of Envirotac II MDD increases upto 4% addition and on further addition it decreases and in case of cement MDD increases upto 15% cement addition.
3. In case of Envirotac II OMC decreases upto 4% addition and on further addition it increases and in case of Cement OMC decreases upto 15% cement addition4.The saving of cost (8% to 14%) is achieved when Envirotac II is used as stabilizer as compared to cement

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Impact Factor: 4.116
CODEN: IJESS7

## VII. REFERENCES

[1] Palmer, J.T., Edgar T.V., andBoresi A.P. (1995) "Strength and Density Modification of Unpaved Road Soils Due to Chemical Additives". Master's Thesis, University of Wyoming.Department of Civil and Architectural Engineering. Laramie, Wyoming.
[2] Santoni, R. L., Tingle, J. S., and Webster, S. L. (2002). "Stabilization of Silty Sand with Nontraditional Additives." Transportation Research Record: Journal of the Transportation Research Board, 1787, 61-70.
[3] Khanbashi-AL, andGamal-El. (2003) "Evaluationof three waterborne polymers as stabilizers for sandy soil". Geotechnical and Geological Engineering, 24: p-1603–1625.
[4] YasrobiShahaboddin and Zandieh Ali reza (2010) " Study of factors affecting the compressive strength of sandy soil stabilized with polymer" journal of geotechnical and geological engineering., vol 28, pp: 139-145.
[5] Iyengar, S.,Masad, &E.Rodriguez(2013) " Pavement subgrade stabilization using polymers: Characterization and performance." Journal of materials in civil Engg. Volume 25, Issue 4, 472-483.
[6] Little, D.N.(1995) "Handbook for stabilization of pavement subgrades and base courses with Lime" Kendall/ Hunt, lowa.
[7] Parsons Robert L(2004) "Use of cement Kiln dust for subgrade stabilization" Kansas Department of Transportation Bureau of Materials and Research, Report No. KS-04-3
[8] Eades, J.L, and Grim, R.E.(1960) "Reaction of hydrated lime with pure clay minerals in soil stabilization .Highway research board Bulletin 262,vol. 98,pp 51-63
[9] PartoPardis (2011) "Laboratory investigation on the Effect of Polypropylene Fibers on the California Bearing Ratio of Stabilized Wind-blown Sand" Electronic jounal of Geotechnical Engineering Vol. 16, Bund. R
[10] IS 2720 part 10 " Methods of test for soil" determination of unconfined compressive strength.
[11] IS 2720 part 16 " Methods of test for soil" laboratory determination of CBR.
[12] IS 2720 part 17 " Methods of test for soil" laboratory determination of permeability.
[13] IS 2720 part 29 " Methods of test for soil" laboratory determination of dry density of soil.
[14] IRC 37-2001 " Guidelines for design of flexible pavement" Indian oads congress new Delhi

## CITE AN ARTICLE

**Kataria, Vikram , Rajdeep Singh, and Asgherhasan. "IMPROVEMENT IN SUBGRADE SOIL BY ENVIROTAC II." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 908-15. Web. 25 July 2017.**