*International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)*
**ISSN: 2456-236X**
Vol. **06** Issue **01** | **2021**

# Stabilization of Expansive Soil by Using Polymers

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**ABSTRACT**

***Soil is one of the most commonly encountered materials in civil engineering. All the structures except some, which are founded on solid rock, rest ultimately on soil. Geotechnical engineers all over the world face huge issues, when structures founded on the soil which is expansive in nature. This expansiveness is imparted to such soils when they contain clay minerals like montmorillonite, illite, kaolinite etc. in considerable amount. Due to the clay minerals, the swelling soils expand on wetting and subjected to shrinkage on drying. These soils are commonly unsaturated.***

***The problem of instability of structures made on such soil is mainly due to lifting up of the structures on heaving of soil mass under the foundation on saturation during rainy season and settlement as a result of shrinkage during summer season. Due to this cavity formed, leading to loss of contact between the soil and structures at some points. This successively results in splitting of structure and failure due to loss of shear strength or unequal settlement.***

***On the contrary, during rainy season the foundation soil swells on imbibition's of water and it is restrained by the foundation. As a result, an upward swelling pressure is exerted by the soil on the foundation. As this pressure is not uniform everywhere, the net downward pressure becomes uneven. Similarly, during the summer season the soil shrinks and this phenomenon is not uniform throughout the soil below the foundation. This additionally results unequal settlement, leading to progressive failure of structures.***

***Investigation into the properties of SoilTech and DustTech treated expansive soils would assess the suitability of using SoilTech and DustTech as stabilizer to reduce swelling of expansive soils. This study presents the effect of marble dust and burnt brick dust stabilization on engineering properties of expansive soil. Soil engineering tests like Atterberg limits, differential free swell test, California Bearing Ratio Test were conducted on virgin soil and stabilized soil.***

***The effects of SoilTech and dust tech on MDD, OMC, soaked CBR of expansive soil stabilized with MD and BDD has been found to be limited in literature The objective of this paper is to study the effects of SoilTech and DustTech on MDD, OMC, soaked CBR, of an expansive soil stabilized with optimum percentage of MD and BDD. The effects of unoaked CBR value have been studied.***

***Keywords- Expansive Soil, Polymers, SoilTech, Dust Tech, Soil Stabilization***

## 1. INTRODUCTION

India has 51.8 million hectares land region that is included with black cotton soil. Various techniques are adopted to enhance the engineering belongings of black cotton soil. Over the past few periods several factors have led to an increase in the number of people migrating to large cities. Consequently, these large cities are getting over populated and quite expectedly necessity of business, residential construction has increased the civil engineering projects located in areas with unsuitable soil is one of the most common problems in many parts of the world. Black cotton Soil can be replaced with stronger material by usual method of soil stabilization.

Main objective of our research is to stabilize the locally available black cotton soil near Akola city. The stabilization is done for the following reasons. Soil stabilization is widely used in connection with road, pavement and foundation construction. It improves the engineering properties of the soil, e.g.: Strength - to increase the strength and bearing capacity, Volume stability - to control the swell-shrink characteristics caused by moisture changes, Durability - to increase the resistance to erosion, weathering or traffic loading. To reduce the pavement thickness as well as cost.

## 2. SOIL STABILIZATION

Soil stabilization is a general term for any physical, chemical, biological or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities & performance of in-situ subsoil, sands & other waste materials in order to strength.

### 2.1 Methods of Soil Stabilizations

There will be four methods of soil stabilization are as follows:

- Mechanical Stabilization
- Physical Stabilization
- Chemical Stabilization
- Physio Chemical Stabilization

### 2.2 Benefits of Soil

- Improve the mechanical qualities of local road construction soil.
- Increase loading capacity.
- Improve structural integrity.
- Reduce harmful moisture penetration.
- Provide longer economic life of road bed.
- Reduce maintenance costs.
- Lower road constructions costs.

### 2.3 Soil Properties:-

Some of the important properties of soils that are used by geotechnical engineers to analyze site conditions & design earthworks, retaining structures, & foundation are-

- Specific weight or Unit weight.
- Porosity.
- Void ratio.
- Permeability.
- Compressibility.
- Shear Strength.
- Atterbegs Limits.

## 3. MATERIAL

### 3.1 Soil Tech Polymers

SoilTech Mk. III is a third generation Nano polymer binder used for stabilizing soils for improving the strength of the soil and thereby improving the stability. It is a stabilization agent and was specifically designed & developed for mine haul road stabilization, where excessive loading occurs and where all-weather roads are required. This technology is now used in commercial road design. The various geotechnical properties of the procured soil are as follows:

Table 1: Standard Properties of Soil Tech Polymer

| S N | Property | Description |
|---|---|---|
| 1 | Appearance | Dark Brown/Black Liquid |
| 2 | Odor | Slight |
| 3 | pH | 8.0-9.0 |
| 4 | Boiling Point | Approximately 100°(as per water) |
| 5 | Flammability | N/A |
| 6 | Vapor Pressure | As per water |
| 7 | Specific Gravity | 7 >1.0 |
| 8 | Water Solubility | Fully miscible |
| 9 | Low plasticity | WL< 35% |
| 10 | Intermediate plasticity | WL< 35% < 50% |
| 11 | High plasticity | WL> 50% |

### 3.2 Dust Tech Polymer

DustTech is a water based polymer emulsion which is sticky to touch apparent odour; totally nonflammable. It is a combination of various water based copolymers including ethelyne glycol, polyvinyl acetate, polyvinyl alcohol stabilizer and colanyl pigment for coloring. DustTech is totally miscible with water and will be progressively diluted if admitted to waterway. The base polymer is slowly biodegraded. DustTech is nonflammable, not hazardous, nontoxic, and environmental free.

Table 2: Properties of Dust Tech Polymers

| S N | Property | Description |
|---|---|---|
| 1 | Appearance | White Liquid |
| 2 | Odour | Slight |
| 3 | pH | 7.0-9.0 |
| 4 | Boiling Point | Approximately 100°(as per water) |
| 5 | Flammability | N/A |
| 6 | Vapour Pressure | As per water |
| 7 | Specific Gravity | 7 >1.0 |
| 8 | Water Solubility | Fully miscible |

Primarily, expansive soils, which represent the extreme soil type, are used.Its liquid limit and plastic limit are found to be 71.75% and 37.5%. As per Indian standard soil classification system for fine grained soil as shown in Figure 3.1 ,theexpansive soil is classified as clay with high plasticity following and the used residual soil is classified as clay with low compressibility

## 4. METHODOLOGY

The Indian Standard codes are as follows:

- Liquid limit test
- Plastic limit test
- Standard Proctor Test
- California Bearing ratio Test
- Optimum moisture and Maximum Dry Density test.
- California bearing ratio- fly ash mixture

### 4.1 Liquid Limit Test

The liquid Limit Test was conducted on soil treated with varying proportion of both SoilTech and DustTech Polymers The result are given in Table.

| Experiment | Liquid Limit |
|---|---|
| Original Soil | 61.75% |
| 0.2% Soiltech | 52.80% |
| 0.5% Soiltech | 51.2% |
| 0.8% Soiltech | 53.20% |
| 0.2% DustTech | 54.3% |
| 0.5% DustTech | 52.1% |
| 0.8% DustTech | 52.5% |

### 4.2 Plastic Limit Test

The plastic limit test was conducted on soil trat with varying proportion of both SoilTech and DustTech polymers. The result is given in table.

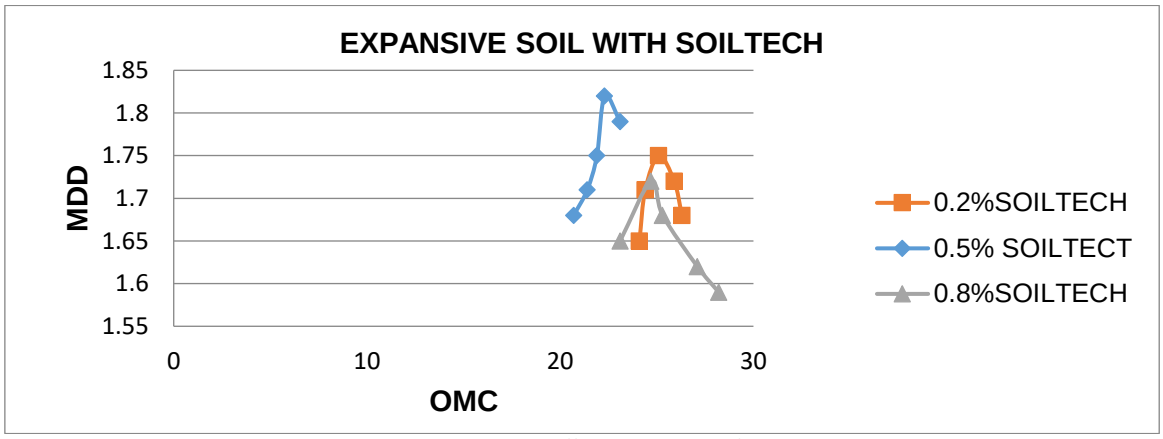
| Experiment | Plastic Limit |
|---|---|
| Original Soil | 31.4 |
| 0.2% Soiltech | 25.10 |
| 0.5% Soiltech | 24.6 |
| 0.8% Soiltech | 25.7 |
| 0.2% DustTech | 27.2 |
| 0.5% DustTech | 26.4 |
| 0.8% DustTech | 26.8 |

### 4.3 Standard Proctor Test

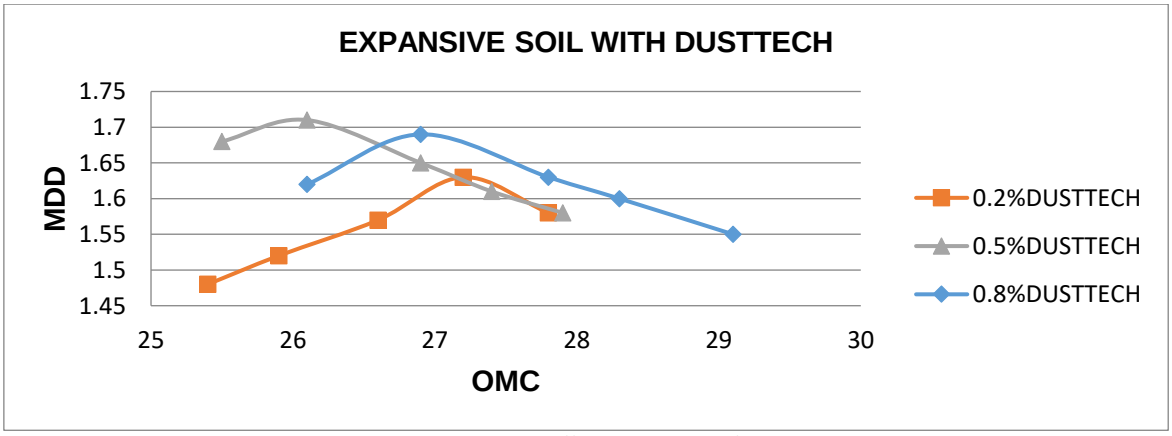
The compaction characteristics of the soil have been studied by varying percentages of SoilTech and DustTech respectively. Compaction curve showing optimum moisture content (OMC) and maximum dry density for different soil is shown in fig 4.1

For original soil sample, The Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) IS shown in below graph.

| %f SoilTech | MDD | OMC |
|---|---|---|
| 0% ST | 1.56 | 29.4 |
| 0.2%ST | 1.75 | 25.1 |
| 0.5%ST | 1.82 | 22.3 |
| 0.8%ST | 1.72 | 27.7 |
| 0% DT | 1.56 | 29.4 |
| 0.2% DT. | 1.63 | 27.2 |
| 0.5% DT | 1.71 | 26.1 |
| 0.8% DT | 1.96 | 26.9 |




Proctor test Result with different percentage of SoilTech



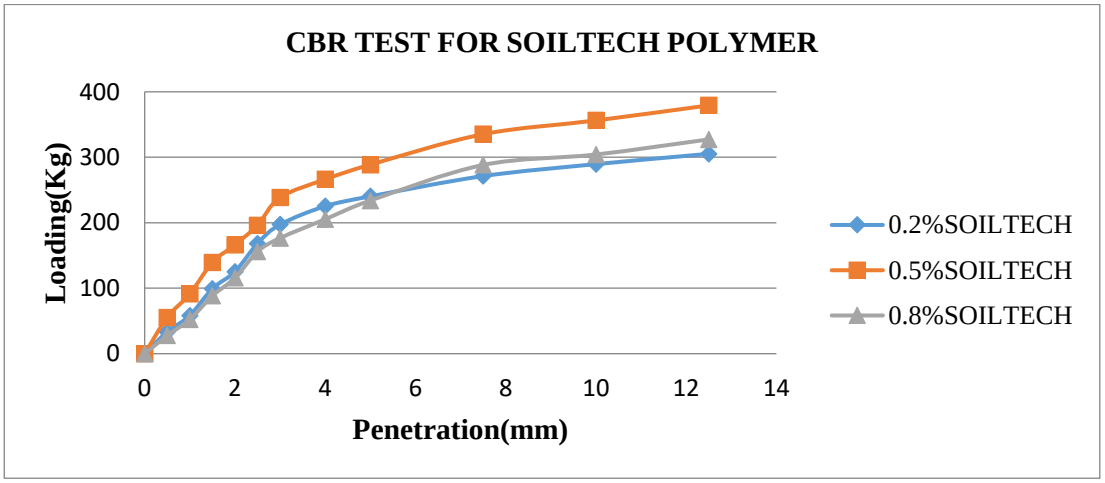

Proctor test result with different percentage of DustTech

### 4.4 California Bearing Ratio

From the obtained result of MDD and OMC of different parentages. The SoilTech and DustTech separate California Bearing Ratio Test were performed. The Various test result of unsoak CBR are Shown in the below figure.
For the original soil, the unsoak CBR rest result were Obtained

| %OF SoilTech | 2.5 mm | 5mm |
|---|---|---|
| 0%ST | 2.4 | 2.2 |
| 0.2%ST | 12.5 | 11.9 |
| 0.5%ST | 14.6 | 14.3 |
| 0.8%ST | 11.6 | 11.5 |

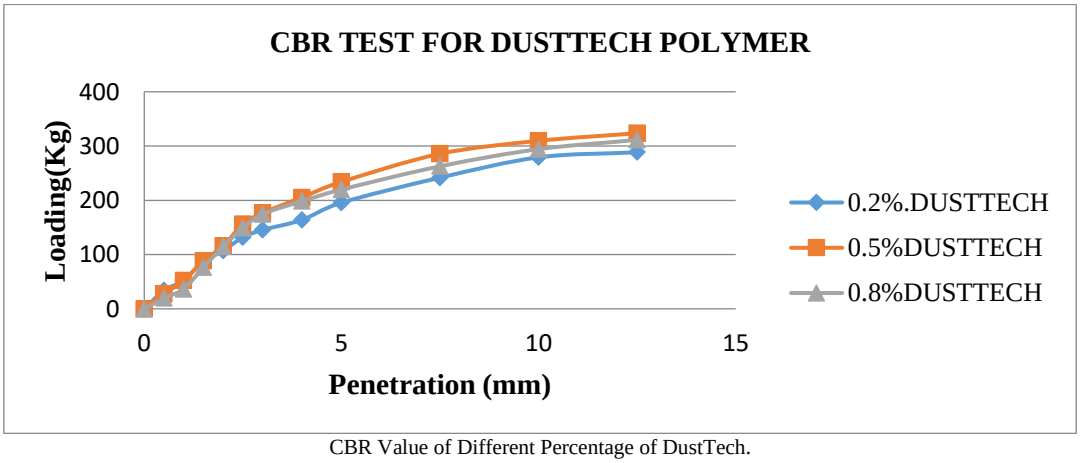
For Soil Treated with Soil Tech Polymer




CBR Value of different percentage of SOILTECH

| %of DustTech | 2.5mm | 5mm |
|---|---|---|
| 0%DT | 2.4 | 2.2 |
| 0.2%DT | 9.8 | 9.7 |
| 0.5%DT | 11.6 | 11.5 |
| 0.8%DT | 11.1 | 10.9 |

For Soil Treated with DustTech Polymer




CBR Value of Different Percentage of DustTech.

### 4.5 Optimum Moisture Content & Max Dry Density Test results on Soil

The optimum value is also increased, the optimum value is obtained at 0.5% of in DustTech which is 11.6 at 2.5 mm penetration and 11.5 at 5mm penetration and farther increase in DustTech polymer CBR curve decreases.

| Description | Proctor Test | | California Bearing Ratio (CBR Test) | |
|---|---|---|---|---|
| | OMC | MDD | 2.5mm Penetration | 5mm penetration |
| Orignel Soil | 29.4 | 1.56 | 2.4 | 2.2 |
| Soil + 0.2% ST | 25.1 | 1.75 | 12.5 | 11.9 |
| Soil + 0.5% ST | **22.3** | **1.82** | **14.6** | **14.3** |
| Soil + 0.8% ST | 24.7 | 1.72 | 11.6 | 11.5 |
| Soil+ 0.2% DT | 27.2 | 1.63 | 9.8 | 9.7 |
| Soil + 0.5% DT | **26.1** | **1.71** | **11.6** | **11.5** |
| Soil +0.8%DT | 26.9 | 1.69 | 11.1 | 10.9 |

All the obtained result are tabulated in the table

## 5. CONCLUSIONS

Many of important engineering properties of soil can be enhanced by the addition of SoilTech and DustTech. The properties of such Soil-SoilTech and Soil – DustTech polymer mixtures very and depend upon the type of soil to develop an understanding of possible mechanism involved a series of experiment through variation of parameter were carried out based on which the following conclusion are follows.

The basic laboratory test conducted on expansive soil shows that the Soil has law strength and high-volume changing property. The high liquid limit 61.75 % and plastic limit 31.4% After stabilizing the soil with varying percentage of SOILECH polymer there was considerable decreases in Liquid limit 61.75% to 51.2% and Plastic Limit 31.4% to 24.6% The effect of both polymers that is SoilTech and DustTech on California bearing Ration Test and swelling of expansive soil have been studied.

It is shown from the test results that the Addition of SoilTech and DustTech Polymeres cause the beneficial changes in the engineering properties of soil. From the projector test result, it was found that increase in addition of SoilTech polymer in expansive Soil the OMC value decreased and MDD is increases up to 0.5% of SoilTech and farther increased in SoilTech i.e., at 0.5% to 0.8% it decreased as compared to original soil.

When SoilTech was added in expansive OMC was decrease up to 22.3 at 0.5% SoilTech and MDD was increased up to 1.82 at 0.5 % SoilTech compared of original soil i.e. OMC29.4 and MDD 1.56 But in DustTech observation was similar but result of DustTech about OMC and MDD was decreased compared to SoilTech but result of DustTech about OMC and MOD was decreased compared to SoilTech polymer i.e. OMC was 26.1 and MDD was 1.71 at some percentage of mixture i.e. 0.5% of DustTech polymer that mean, SoilTech is better than DustTech .DustTech also good stabilizer for stabilization soil.

From CBR test result, it was found that CBR for original soil at 2.5 mm penetration 2.4, After adding SoilTech and DUSTTECH separately, there was sadden jump in CBR value. Adding SoilTech for CBR Test at 0.5% was found 14.6 at 2.5 mm penetration and 14.3 at 2.5 mm penetration, as we seen huge different it was gain That mean SoilTech polymer is beneficial stabilizer for improve the ground. After more adding soil Tech polymer it was decreased the graph was found in observation. That means the 0.5% of SoilTech polymer proportion is beneficial.

For CBR test, using DustTech at various parentages, the CBR value was increased at 2.5 mm penetration 9.8, 11.6, 11.1 and at 5mm penetration 9.7, 11.5, 10.9 for 0.2% ,0.5%, 0.8% of DustTech respectively. It was found that 0.5% of Dust tech has peak CBR value. The expansive soil can be well stabilized with SoilTech polymer and DustTech polymers then expensive stabilized soil on their addition.

From the result it is concluded that the impact to polymers like soil Tech and Dust tech is positive. So, use of soil Tech and Dust tech is Preferable of stabilization because it given positive result as Stabilizers.

## 6. REFERANCE

[1] T.Raghvendra, B.Rohini, G.Divya,"Stabilization of black cotton soil using terrasil and zycobond" IJCRT 2018 , ISSN:2320-2882(PAPER) National Conference Proceeding NTSET feb 2018

[2] P.K.Kolay ,A.Pant ,V.K.Puri ,"Effect of liqyid polymer stabilizer on geotechnical properties of fine-grained soil", Indian Geotechnical Conference IGC 2016 IIT madras, Chennai.

[3] Samer Vyas, NeelamPhaugal , Pankaj Sharma , "stabilisation of dispersive soil by blending polymers", International Journal of earth science and Engineering ISSN:0974-5904, VOLUME 04, No. 06 SPL, PP 52-54, 2011

[4] N.Sohaib , M. SarfrazFaiz , G.Sana "Use of acrylic polymer for stabilisation of clayey soil" International Journal of Scientific and engineering research, Vol.9 ,Issue 11, ISSN 2229-5518, 2018

[5] LarisaChabdris, Dan Paul, LaelislauRandermanchere "Expansive soil stabilisation – genral consideration "Internatinal Multidisciplinary scientific Geo conference SGEM 2017

[6] Anjaneyappa, Dr. M.S. Amarnath and B.R. Shrinivasamurthy“ Characterisation of polymer stabilised soil for [avment “ Indian Road Congress Polymer Paper.
[7] AthulyaP.V., Dr.R.SathusChandran “stabilisation of subgrade soil using additives –a case study “ ISSN:2278-0181 , NCRACE -2015 , International Journal of Engineering Research and Technology , IJERT.
[8] BibhaMahto, A.K.Duggal “ Areveve paper on important of subgrade by RBI grade 81 and ash pond “ e-ISSN:2395-0056 , P-ISSN:2395-0075 , IRJET 2015
[9] BasantaDhakal , Sanjeev Kumar , PrabirKolay “ Effect of liquid acrylic polymer on geotechnical properties of fine grained soil” Springer International Publication Switzerland 2016.
[10] Qassun S. mohammadShafiqu and Safe H Bdan“improvement on expansive soil using polymethacrylate polymer “ International Conference on material Engineering and Science 454 (2018) , 012138
[11] Case study – evaluation report of SoilTech treated soil stabilised base layer by reliance power limited
[12] SepehrRezaeimalek ,JieHuange, Sazzad Bin Shalique “ mixing method evaluation of styrene , acrylic based liquid polymer for sand and clay stabilization “ ISBN: 978-1-60595-442-4, ICTIM 2017.
[13] J.Ranjitha, Supriya D.K.,Hitaishi.P, Pratik kumR , “ Experimental Study On Black Cotton Soil Stabilised Using Soiltechmk 3 Polymer “ e-ISSN :2319-1163 , p-ISSN :2321-7308 IJRET.
[14] Gupta, C. and Sharma, R.K. (2014) “Influence of Marble Dust, Fly Ash and Beach Sand on Sub-Grade Characteristics of Expansive Soils,” International Conference on Advances in Engineering and Technology -2014(ICAET-2014) Spl. Publication of IOSR Journal of Mechanical and Civil Engineering,13-18.
[15] Hakari, U.D. and Puranik, S.C. (2012) “Stabilization of Black Cotton Soil using Fly Ash,Hubbali-Dharwad Municipal Corporation Area, Karnataka, India,” Global Journal of Researches in Engineering- Civil and Structural Engineering, 12(2),Version 1.
[16] Hardaha, R.P, Agrawal, M.L. and Agrawal, A. (2013) “Use of Fly Ash in Black Cotton Soil for Road Construction,” Recent Research in Science and Technology, 5(5), 30-32.
[17] Havanagi, V.G., Prasad, P.S., Guruvittal, U.K. and Mathur, S. (2006) “Feasibility of Utilization of Copper Slag –Fly Ash –Soil Mixes for Road Construction,” Highway Research Bulletin, 75, 59-67.
[18] Ijimdiya, T.S., Ashimiyu, A.L., and Abubakar, D.K. (2012) “Stabilization of Black Cotton Soil using Groundnut Shell Ash” Electronic Journal of Geotechnical Engineering, 17 (Y), 3645-3652.
[19] Ji-ru, Z. and Xing, C. (2002) “Stabilization of Expansive Soil by Lime and Fly Ash,” Journal of Wuhan University of Technology-Materials Science Edition, 17 (4), 73-77.
[20] Joel, M. and Agbede, I.O. (2011) “Mechanical-Cement Stabilization of Laterite for Use as Flexible Pavement Material” Journal of Materials in Civil Engineering, 23 (2), 146152.
[21] Koyuncu, H., Guney, Y., Yilmaz, G., Koyuncu, S., and Bakis, R. (2004) “Utilization of Ceramic Wastes in the Construction Sector,” Key Engineering Materials, 264-268, 2509-2512.
[22] Malhotra, B.R. and John, K.A. (1986) “Use of Lime –Fly Ash-Soil-Aggregate Mix as a Base Course,” Indian Highways, 14(5), 23-32.
[23] Maneli,A., Abiola,O.S., Kupolati,W.K. and Ndambuki,J. (2013) “Evaluation of Fly Ash and Ground Granulated Blast Furnace Slag on Consistency Limits of Black Cotton Soil,” OIDA International Journal of sustainable development, 6(10), 49-54. Vol. 19 [2014], Bund. U 6264
[24] Manikandan, A.T. and Moganraj, M. (2014) “Consolidation and Rebound Characteristics of Expansive Soil by Using Lime and Bagasse Ash,” International Journal of Research in Engineering and Technology, 3(4), 403-411. 36. Mir, B.A. and Sridharan, A. (2013) “Physical and Compaction Behaviour of Clay SoilFly Ash Mixtures,” Geotechnical and Geological Engineering, 31, 1059-1072.
[25] Mishra, J., Yadav, R.K. and Singhai, A.K. (2014) “Effect of Granite Dust on Index Properties of Lime Stabilized Black Cotton Soil,” International Journal of Engineering Research and Science & Technology, 3 (1), 19-23.
[26] Misra, A., Biswas, D. and Upadhyaya,S. (2005) “Physico-Mechanical Behavior of Self- Cementing Class C Fly Ash –Clay Mixtures,” Fuel, 84(11), 1410-1422.
[27] Misra, A.K., Mathur,R., Goel, P. and Sood, V.K. (2004)“Use of Phosphogypsum-An Industrial By-Product in Stabilization of Black Cotton soils,” Highway Research Bulletin,70,65-75.