International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 8, August-2018

Effect Of Bagasse Ash And RBI Grade-81 On Geotechnical Properties Of Expansive Soil

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Abstract — : Large area of land in India are covered with Expansive soils (mainly Black Cotton soil). The nature of these expansive soils is that they are quite strong when in dry state, but they lose all of their strength when in wet state. Keeping in view the nature of these soils, their nature poses problems worldwide and acts as challenge for the Geotechnical engineers. One of the essential factors for construction purposes is soil stabilization, and is used usually in foundation and road design. This is the reason why a stabilization process improves engineering properties of the soil such as stability, shear strength and durability. Replacement may be done using better material, otherwise the soil is treated with a stabiliser. Soil sample of Bagasse ash had a comparatively higher strength, lower value plasticity index than original soil. The addition of Bagasse Ash in the expansive soil gave large increase in strength and reduced swelling properties. For doing various tests, the expansive soil was mixed with Sugarcane Bagasse Ash (SBA) from 0% to 20% at an increment of 5%. RBI grade 81 was mixed with expansive soil from 0% to 6% at an increment of 2%.The Liquid linit test, plastic limit test, standard proctor compaction test, unconfined compressive strength test were done on expansive soil in light of Indian standard (IS) codes. The institutions which are involved in the construction of road pavements, highway embankments, railways, building foundations can use these results in the field of soil stabilization with advantage.

Keywords - Expansive Soils , Bagasse Ash , Liquid Limit , Plastic Limit , Swelling Properties , Standard Proctor Test , Plasticity Index .

I. INTRODUCTION

Large portion of land of India is covered with expansive soils. After the fast increase in industrialization and urbanization, land scarcity is becoming a great threat to humans. Construction of various structures on expansive soils poses a major risk to the structure because of the large degree of instability in these expansive soil. It is recorded that billions of dollars per year is the loss in property every year globally due to the instability in the expansive soils. Also, disposal of bagasse ash is becoming a critical issue. This study is mainly dealing with improvement of swelling characteristics of expansive soil by addition of bagasse ash and RBI grade 81. The construction in expansive soils is very much challenging due to its swelling and shrinkage properties. To overcome this issue there are two solutions. One is replacing the expansive soil by good quality stabilising material. The second method is to stabilize expansive soil by using different industrial wastes. So we are using Sugarcane Bagasse ash and RBI grade 81 for stabilization of expansive soil.

During making of juice a large amount of sugarcane bagasse is produced which is burnt at around 500^0C to make it bagasse ash. But according to my study, compaction characteristics are not improved to a large extent by using SBA as stabilizer. So we used an additional stabilizer RBI Grade 81. RBI Grade 81 a natural Soil Stabilizer is a unique and newly built material that was developed for the stabilization of a wide spectrum of soils in an efficient and least-cost way. The failure of roads constructed on expansive soils is generally due to swelling and shrinkage properties. The mix of various industrial wastes and RBI Grade 81 in the soil helps to reduce these characteristics. The use of these industrial wastes in construction or roads also helps in reducing the problem of disposal of wastes. SBA is collected from “Samba”. RBI Grade 81 one bag weight 5kg was taken from registered supplier in New Delhi. Expansive soil has collected from potters of village Chaka doda for the effect on geotechnical properties when mixed at various proportions.

The purpose of the work is to use a Stabilizer RBI Grade 81 and Sugarcane Bagasse ash (SBA) collected from sugar mill for the improvement in engineering properties of expansive soil. The use of these stabilizers is done to enhance the shear strength properties of soil and improving the shrinkage and swelling properties of soil. The collected soil samples of expansive soil are treated with RBI 81 and SBA in various mix proportions.

II. LITERATURE REVIEW

Anup Gajanan Bombatkar (2016) studied that Black cotton soils have high degree of expansion and possess high swelling potential and require stabilization for their better performance. The present work shows 1 to 5% of RBI grade 81 can have a significant effect on the stabilization of a fine material. The index parameters of study soils improve with the addition of RBI grade 81. The liquid limit decreases from 73.79% to 60.33%, plastic limit from 34.42% to 28.10% and the plasticity index from 39.37% to 32.23% for corresponding increase of RBI grade 81 from 0, 1 up to 5%. The CBR value increases from 2.59% for 0% RBI grade 81 to 8.37% for 3% RBI grade 81. Any further increases in addition of % of RBI grade 81 do not increase CBR value. By using RBI Grade-81 cost reduction in road pavement is 15.63% .

Bibha Mahto et al. (2015) studied that RBI Grade 81 is successful in adjustment of most sorts of soils. The increment in CBR esteem fluctuates w.r.t sort of soil. For some soils, the augmentation is substantial with little expansion of the chemicals like fly ash, Sodium Silicate, pond ash, moorum and stone dust. Since RBI Grade 81 assistance to use by regional standards accessible soil for road construction, consequently the expense of construction can be diminished by maintaining a strategic distance from substitution of soil.

Saiful Azhar Ahmad Tajudina et al. (2015) studied that the utilization of SCBA is possible partial replacement material to treat the contaminated soil, especially by heavy metals. Overall, the use of SCBA has successfully obtained the highest strength compared to the sample containing OPC alone. However, all samples are observed to exceed the landfill disposal limit of 340 kPa for waste except control samples that are slightly below the regulatory limit

Manisha Gunturi et al. (2014) had given the paper "Study on strength characteristics of soil using soil stabilizer RBI 81". In this paper the influence of RBI grade 81 on the strength and microstructure of the soil has been studied. The result of this paper shows that the increase in percentage of RBI 81 on the soils increases the UCS value of the soils.

Tejinder Singh et al. (2014) studied about the impact of stabilizer RB1-81 in the stablization of soil with the assistance of Atterberg's limit, Standard Proctor test & CBR test to figure out the escalation of soil and for the analysis of expense difference between conventional method and expense of making pavement for soil with +2% RB1-81. Amid this test wet sieve analysis was completed for influential particle size distribution. Liquid limit and plastic limit tests were likewise led to concentrate on the impact of RBI - 81on list property of soil. CBR specimens were likewise arranged with diverse rate of RBI-81 i.e. (0%, 2%, 4%, 6% and 8%) with water content of 1% + OMC. After the investigation the conclusion was made that the profoundly plastic soil be able to be settled with RB1-81 and be able to be considered as balanced out sub base. Amid this examination it has additionally be seen that the CBR expanded with expansion of RB1-81.

Anitha.K.R et al. (2014) research the impact of utilizing another stabilization item, RB1-81 on kaolinite, red soil, & Lateritic soil. This study revealed that both soaked and un-soaked CBR expanded altogether with the expansion of RB1-81 for Red soil, lateritic& kaolinite soil. Amid this analysis the CBR specimen were readied with diverse rate RB1-81 i.e. [0%, 2%, 4%, 6%, & 8%] water substance of 1% + OMC was included for readiness of example. CBR test were done at 0, 7 & 11 days of curing. CBR test at 11 days was done subsequent to dousing for 4 days, for the specimen which has been cured for 7 days. After all examination the creator reached the conclusion that un-soaked CBR did not fluctuate much for red soil and lateritic but rather it expanded 16 times for kaolinite. It has additionally been found that soaked CBR expanded 16, 14 & 4 folds with the expansion of ideal rate of RB1-81 suggested for red soil, lateritic and kaolinite separately.

Nur et al. (2014) studied the effect of cement content (0, 7, 13% by weight) of Kaolin clay soil with LL=54% and PI=24.8% treated with cement and cure for 7 days and found that the CBR value increased with the increasing of percentage of cement. CBR value equal to 16, 76 and 110% for 0, 7 and 13% cement were attained respectively.

Grytan et al. (2012) investigated the effect of cement on UCS of soil with LL=46% and PI=19% at different percent of cement content for 0, 7 and 28 days curing and found that the value of UCS gradually increased for both un-soaked and soaked samples. They also observed that the value of compressive strength increases with the increases of soaking days for cement treated soil, whereas the untreated soil shows the compressive strength decreases with the increasing of soaking days.

III. MATERIALS USED AND METHODOLOGY

A . Expansive Soil :

Expansive soils are also known as swell-shrink soil. They have the tendency to shrink and swell with seasonal variations. As a result of this variation in the soil, significant changes occurs in the soil, that is subsequently followed by damage to the overlying structures lying over it .When there is portion of large moisture like monsoons, expansive soils absorbs the water and swell up. Consequently, soil becomes soft and its water holding capacity reduces. On the other side during drier seasons like summers, expansive soils loose the moisture held within them due to evaporation which results in their hard nature .Generally expansive soils are found in arid regions of the earth. These type of soils are treated as natural hazard if these are not treated. These can cause very large damage to the structures built on them, also may cause loss in human life. Soils which are having mineral montmorillonite in general, shows these properties, These soils have caused large damage to civil engineering structures. Also known as Black Cotton soils or Regur soils, expansive soils in the Indian subcontinent are mainly found over the Deccan trap , which includes Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh, and some scattered places in Orrisa and j&k.

Figure 1 : Expansive Soil

B . Sugarcane Bagasse Ash :

Bagasse is the residual matter that remains after sugarcanes are crushed to extract their juice. It is residue which is left after the juice is extracted from sugarcane. Bagasse is sometimes used as a biofuel and hence effective in the manufacture building materials. Sugarcane bagasse ash is a byproduct from factories of sugar found after burning sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this sugarcane bagasse may cause environmental problems near the sugar factories. Also, the increase in construction activities in our country created shortage in various concrete making materials largely cement, that results in increase in its price. This work depicts the use of sugarcane bagasse ash as a cement replacing material.

Figure 2 : Sugarcane Bagasse

Figure 3 : Sugarcane Bagasse Ash

C . RBI Grade 81 :

RBI means Road Building International, RBI 81. It is natural stabilizer which is having low cost and is environment friendly. The use of RBI Grade 81 makes the liquid limit to decrease and the plastic limit to increase and thus decreasing the plasticity index of expansive soil. RBI grade 81 contains fibers in it which helps in reinforcing the soil. It is an odourless powder. It is insoluble in water and works by hydration reaction and hence it is chemically stable. It improves the shear strength of soil. It is highly effective in expansive soils having low geotechnical properties.

The strength of courses of road is usually measured in terms of California Bearing Ratio (CBR) value. The thickness of pavement depends on California bearing ratio value of sub grade soil, base course and traffic volume. The California bearing ratio value of expansive soil in the presence of water is low which it is not suitable as a sub-grade material of the pavement.

Figure 4: RBI grade 81

D . Tests Involved :

To achieve the objective of the work , the following tests were performed as per Indian standard codal provision:

- Atterberg's limits test (IS: 2720, Part-V),
- Compaction characteristics test (IS: 2720, Part-VII),
- Unconfined Compressive Strength test (IS: 2720, Part-X).

Atterberg's limit test is the test to determine the state of soil in which soil exist. On the basis of the Atterberg's limit test, the classification and compressibility behavior of the soil can be investigated, due to which it is found that soil is highly compressible or low compressible. The compressibility behavior can be checked with the help of liquid limit and plasticity index value in the Plasticity chart. The following Atterberg's limits were determined:

- Liquid Limit
- Plastic Limit
- Plasticity Index

The addition of water to a dry soil helps in bringing the solid particles together by coating them with thin films of water. At low water content, the soil is stiff and is difficult to pack it together. As the water content is increased, water starts acting as a lubricant, the particles start coming closer due to increased workability and under given amount of compactive effort, the soil-water-air mixture starts occupying less volume, thus effecting gradual increase in dry density. As more and more water is added, a stage is reached when the air content of soil attains a minimum volume thus making the dry density a maximum.The water content corresponding to maximum dry density is called optimum moisture content.Addition of water beyond the optimum reduces the dry density because the extra water starts occupying the space which the soil could have occupied. Increase in compactive effort or the energy expended will result in an increase in the maximum dry density and and a corresponding decrease in the optimum moisture content.Thus for purpose of standardization especially in the laboratory, compaction tests are conducted at a certain specific amount of compactive effort expended in a standard manner.

IV. RESULTS AND DISCUSSIONS

Table 1 : Variation Of LL, PL And PI For Various Proportions Of Soil, SBA And RBI Grade 81

Soil: SBA: RBI 81 (%)	Liquid Limit (%)	Plastic limit (%)	Plasticity Index (%)
100 : 0 : 0	50.4	25	25.4
93 : 5 : 2	48.1	26.1	20
88: 10 : 2	48	26.5	21.5
83 : 15 : 2	46	26.8	19.2
78 : 20 : 2	45	27	18
91: 5 : 4	43	27.7	15.3
86 : 10 : 4	41	28.57	12.43
81 : 15 : 4	42	27	15
76 : 20 : 4	42.8	26.8	16
89 : 5 : 6	43	25	18
84 : 10 : 6	44	23	21
79 : 15 : 6	45	22.8	22.2
74 : 20 : 6	43	25	18

A . Atterberg's Limit Test :

Atterberg's limit defines the state of soil in which it exists. This test includes the determination of liquid limit, plastic limit and plasticity index of clay. It has been found that there is decrease in the liquid limit and plasticity index till optimum mix (84: 10: 06) after that increases. There is decrease in the value of liquid limit from 50.4 % to 41 % and from 25.4 to 12.43 in case of plasticity index and there is increase in the case of plastic limit from 25 % to 28.57 %.

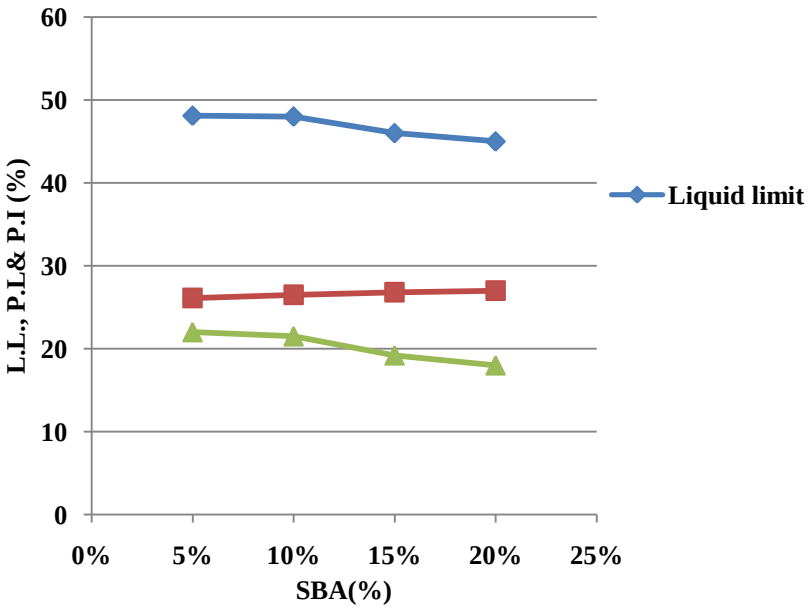

Figure 5 : Atterberg's limits of mix having 2% RBI with various proportion of SBA and Soil

Figure 5 shows the Atterberg's limits i.e. liquid limit, plastic limit and plasticity index of the clay mixed with 2% of RBI grade 81 with 5 %, 10%, 15 %, 20 % of Sugarcane Bagasse ash. It shows that at 2% RBI grade 81 the liquid limit of the mix decreases as the content of SBA increases. In case of plastic limit the effect is opposite to liquid limit, as plastic limit increases with increase in SBA. The plasticity index curve shows same results as liquid limit.

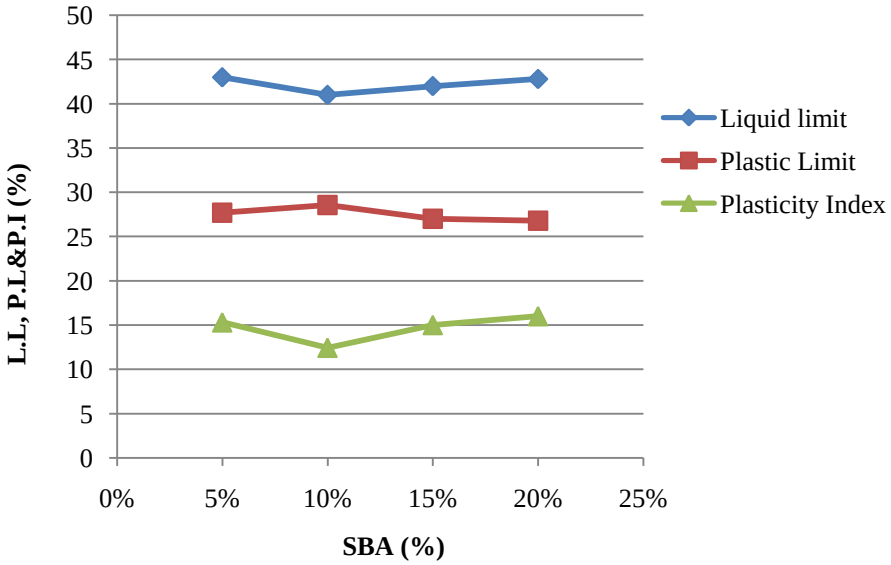

Figure 6 : Atterberg's Limits Of Mix Having 4% RBI With Various Proportion Of SBA And Soil

Figure 6 shows the Atterberg's limits of the clay mixed with 4% of RBI grade 81 with 5 %, 10%, 15 %, 20 % of Sugarcane Bagasse Ash. It shows that at 4 % RBI grade 81 the liquid limit of the mix decreases as the content of SBA increases at 10% SBA after that liquid limit increases. In case of plastic limit there is increase in the value with increase in SBA content at 10 % after that it decreases. The plasticity index curve shows opposite results of plastic limit.

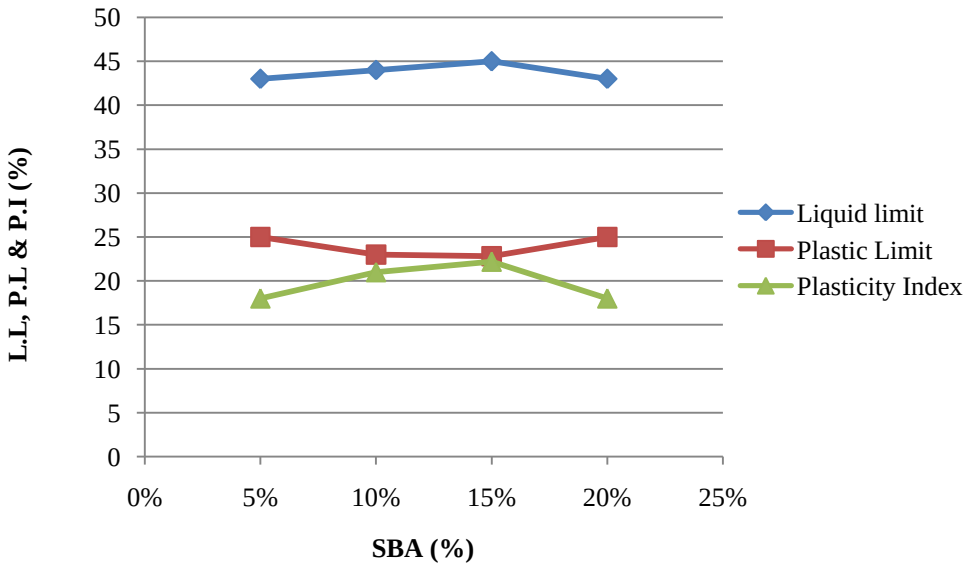

Figure 7 : Atterberg's Limits Of Mix Having 6% RBI With Various Proportion Of SBA And Soil

Figure 7 shows the Atterberg's limits of the clay mixed with 6 % of RBI grade 81 with 5 %, 10%, 15 %, 20 % of Sugarcane Bagasse Ash. It shows that at 6 % RBI grade 81 the liquid limit of the mix decreases as the content of SBA increases at 10% SBA after that liquid limit increases. In case of plastic limit there is increase in the value with increase in SBA content at 10 % after that it decreases. The plasticity index curve shows opposite results of plastic limit.

B . Moisture–Density Relationship :

As the amount of Sugarcane Bagasse ash content and RBI grade 81 increases the optimum moisture content increases and decreases the maximum dry density till optimum mix i.e. 84 % of clay + 10 % of Sugarcane Bagasse ash + 6% RBI grade 81. The MDD and OMC values for 100 % expansive soil are 1.87 g/cc and 11% respectively. The MDD and OMC for the optimum mix are 1.76 g/cc and 20%, respectively. The optimum mix is determined from the consistency's limit tests. The OMC increases due to extra water requirement for higher fineness and subsequent enhanced hydration.The MDD decreases due to flocculation of soil particles and due to the fact that in soil there is always a water content to produce maximum strength untreated.

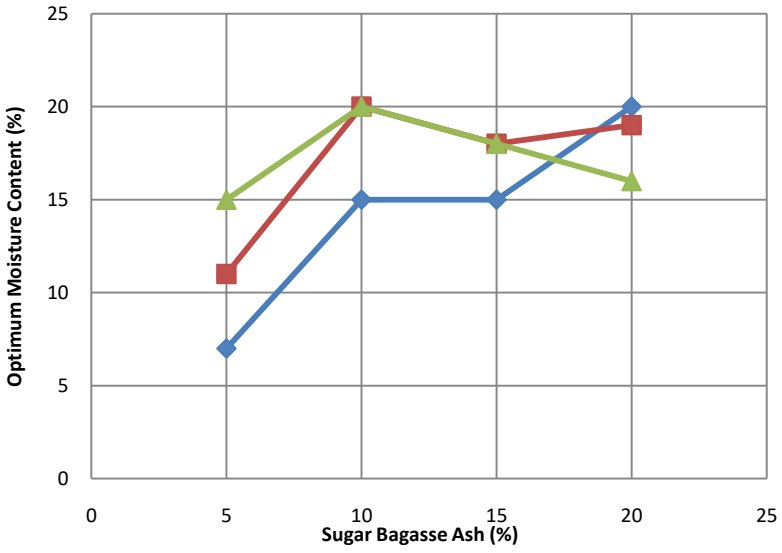

Figure 8 : OMC v/s Percentage of SBA with 2%, 4%, 6% of RBI with different proportions of Soil

Figure 8 shows the optimum moisture content of 2 %, 4 % and 6 % RBI grade 81 at different proportions of SBA i.e. 5 %, 10 %, 15 %, 20 %. As per the graph of 2 % RBI grade 81 the OMC value increases at 10 % and remain same till 15 % after that it increase. In the 4 % graph,value increases at 10 %, decreases at 15 % after that increases at 20 %. In the case of 6 % addition of RBI grade 81 value increases at 10 % after that it decreases.

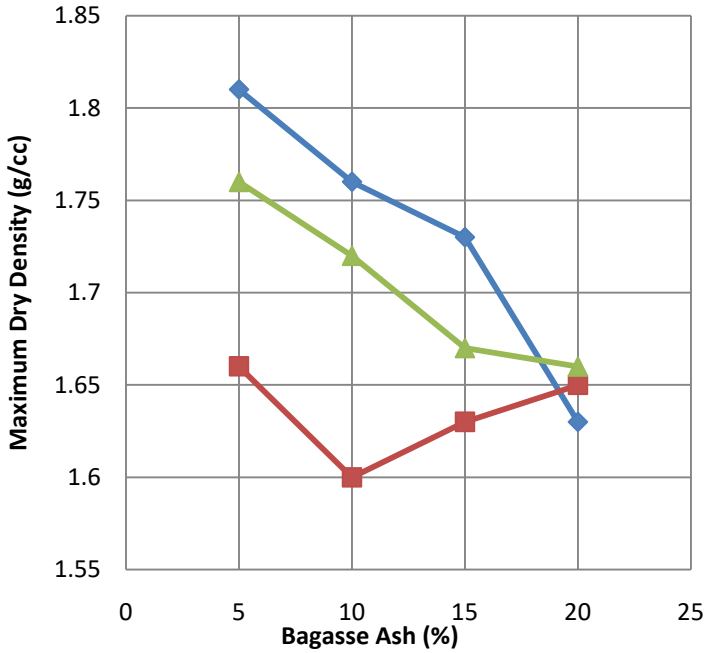

Figure 9 : MDD v/s Percentage of SBA with 2%, 4%, 6% of RBI with different proportions of clay

Figure 9 shows the maximum dry density of 2 %, 4 %, and 6 % RBI grade 81 at different proportions of SBA i.e. 5 %, 10 %, 15 % and 20 %. As per the graph of 2 % RBI grade 81 the MDD value goes on decreases. In the 4 % graph values decrease at 10 %, after that goes on increases. In the case of 6% addition of RBI grade 81 values goes on sudden decreases till 15 % after that it goes on little decrease.

Table 2 :Variation of MDD and OMC values of various mix proportion

Clay: SBA: RBI 81 (%)	MDD (g/cc)	OMC (%)
100 : 0 : 0	1.87	11.11
93 : 5 : 2	1.81	7
88 : 10 : 2	1.76	15
83 : 15 : 2	1.73	15
78 : 20 : 2	1.63	20
91 : 5 : 4	1.66	11
86 : 10 : 4	1.6	20
81 : 15 : 4	1.63	18
76 : 20 : 4	1.65	19
89 : 5 : 6	1.76	15
84 : 10 : 6	1.72	20
79 : 15 : 6	1.67	18
74 : 20 : 6	1.66	16

V . CONCLUSION AND SCOPE OF WORK

1. The optimum mix is found to be 86% clay, 10 % SBA and 4 % RBI on the basis of consistency limit test and compaction test.

2. As the work is on expansive soil with addition of SBA and RBI grade 81 and it shows effective results for the stabilization of expansive soil. In the field of stabilization of sub grades, there is a lot of scope for further work. Similar stabilization can also be done by using various other materials available, one of the most important is RBI grade 81. It is a very new patented material and has large scope in research work. Stabilizations can be performed on different types of soil.

3. The RBI grade 81 has the properties that it can also be mixed with other materials which have high amount of silica content in it. The stabilization can also be done with different combinations of stabilizers like cement and lime mixed together, RBI grade 81 with fly ash, pond ash etc. This stabilization is very important in the design of flexible pavement for stabilizing the subgrade so that chances of settlement can be minimized which occurs due to absorption of water by subgrade.

4. With the help of stabilization the absorption of water by the pavement is restricted. The stabilization makes the soil dense and in pavements the subgrade is treated as base layer that works similar to the cemented layer pavements. The stabilized soil layer can bear much load as compare to untreated layer.

5. There are several reasons for using stabilization technique for the improvement of various factors such as subgrade of poor conditions, construction of superior bases, moisture control, dust control and repairing old roads. The stabilization is used to construct economical roads, maintenance of unpaved roads, rehabilitation of failed roads, construction of roads and parking areas etc.

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