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Stabilize Black Cotton Using Waste Materials

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Abstract - *Expansive soil creates difficulty while construction Because of existence of microscopic minerals like montmorillonite. These soils have major distribution everywhere the India. These soils proved dangerous without stabilization. Researchers have used different stabilizers to enhance the properties of expansive soil. Per annum new project starts for the event of country for instance expressways, railways, bridges, small or big dams, weirs, retaining structures and astray everyday numbers of buildings are constructed and demolished. the most important problem of construction is its construction in weak soil areas especially on black cotton soil thanks to its low California bearing ratio (CBR) and another one is lateritic soil. This results in stabilize the soil underneath by improving their characteristics either by mechanical or by adding low cost locally available eco-friendly admixtures. consistent with the research reviews the wastes are utilized for stabilization. These stabilized soils are often used as a fill material for embankment, sub base or sub grade to utilize the waste , saves the land consumption for dump, optimize the value of fabric . during this paper the weak soils i.e. black cotton soil and lateritic soils are practiced to stabilized with sugarcane biogas plant sludge and construction demolition waste and their comparative study is administered using different tests like liquid limit, plastic limit, MDD, OMC and therefore the most vital CBR tests.*

Key Words: *Black cotton soil, construction and demolition, sludge, stabilisation, liquid limit, plastic limit, Standard proctor test, California bearing ratio (CBR)*

1. INTRODUCTION

The soil, which is lying at the bottom of footing, supports the structure and effectively distributes the load of the structure. If the soil is poor and its properties are weak, it's going to cause damage and depressions in pavements, cracks within the superstructure, damage in foundation, damage in retaining structures and even the unequal settlement of the structure. The black cotton soil is that the sort of expansive soil which has the properties of shrinkage and swelling. The distribution of black cotton soil is 46 lakh sq.km.(16.6% of the entire area) across Maharashtra, MP, Telengana, etc. It contains 10% alumina,, 9-10 you look after iron oxide, 6-8 per cent of lime and magnesium carbonates, Potash is variable(but 0.5%) and phosphate, nitrogen, and humus are low. It contains montmorillonite clay in great deal which is liable for high swelling and shrinkage property of BC soil. Similarly, the lateritic soil is additionally categorized in weak soil. The distribution of lateritic soil in India is across the Maharashtra, Deccan plateau and most of the south state. This soil are often used as a construction material. Lateritic soil is that the soil which becomes soft when wet and becomes very hard when dry. These weak soils got to be treated while construction is formed thereon . Lateritic may be a soil and rock type rich in iron and aluminium, and is usually considered to possess formed in hot and wet tropical areas. Nearly all laterites are of corroded-red coloration, due to high iron oxide content. They develop by through and continued weathering of the underlying parent rock. Tropical weathering (laterization) may be a prolonged process of chemical weathering which produces a good variety within the thickness, grade, chemistry and ore mineralogy of the resulting soils. The formation of lateritic soil involves physico-chemical breakdown of primary minerals and therefore the release of constituent elements (SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, K_2O, Na_2O, etc), which appear in simple ionic forms; leaching (laterization) under appropriate conditions, of combined silica and bases and therefore the relative accumulation or enrichment of oxides and hydroxides of Sesquioxides (Fe_2O_3, Al_2O_3, and TiO_2); and partial or complete dehydration (sometimes involving hardening) of the Sesquioxide rich materials and secondary minerals. Laterites occur mostly in tropical and sub-tropical regions with hot, humid climate . it's been suggested that a minimum annual temperature of around 250c is required for his or her formation, and in seasonal situations there should be a coincidence of the nice and cozy and wet periods. If there's high rainfall during the cold seasons, laterite doesn't develop freely. The minimum rain fall required for the formation of laterites is usually a minimum of 750mm.The higher rain fall above this value, the greater

the leaching effect, which removes the silica, reducing the Silica/Sesquioxide ratio and increase the degree of laterization. Lateritic soil generally has low bearing capacity and low strength thanks to high content of clay. When lateritic soil contains an outsized amount of clay materials its stability and strength and stability can't be guaranteed under load in presence of moisture. It consists of high plastic clay; the plasticity of the soil may develop cracks and damage on pavement, roadways, building foundations or any engineering construction projects.
Many researchers used differing types of organic, non organic, costly, low costly available materials for the stabilization of those two soils. Some authors used mixing of two or more sorts of soils to see the variation in their physical properties. So as India is developing country daily new construction projects of transportation are started. And as pavement must be strong for carrying of vehicles load the soil on which they construct must be strong enough to sustain the pavement. Another problem in India is of disposal of waste. As India is developing country, the amount of population are increases simultaneously construction and demolition projects are rising. C&D waste contributes Soil, Sand & Gravel (36%), Brick & Masonry (31%), Concrete (23%), Metals (5%), a Bitumen (2%), Wood (2%) , Others (1%). because it such an enormous amount of waste that ought to be utilized during a great way . So, taking this into consideration during this paper it's tried to attenuate this waste by using it as a stabilized material for soil and this weak soil are often utilized as a fill material. this massive production of demolition waste is required to be manage, utilized because it can't be degrade to attenuate the space. So it are often used as construction material for pavement or the other construction projects like filling material for landfills, embankment, dams etc. during this paper black cotton soil and lateritic soil are practiced to stabilized with construction and demolition waste and another material which is sludge collected from biogas plant of sugar industry. In Maharashtra large production of sugar is administered . The waste of sugarcane is produced in terms of organic material which may be used for production of biogas. When biogas is produced sludge is that the output of it from biogas plant these sludge is remain idle on site. As, dried sludge is employed by brick manufacturing bhatti's for improvement of strength of bricks. during this paper it's tried to use the dried sludge for studying the variation of properties of both the soils.

1.1 Objective of the Study

The primary objective of this study is to realize improvement of soil characteristics with better load bearing capacity, so on achieve a sustainable development in utilizing these stabilized soil using locally available industrial waste as a sub-grade, sub base material for pavement construction or fill material in order that the utilization of weak soil and waste disposal are often done properly.

- To study the geotechnical properties of the black cotton soil before and after adding the sugarcane plant biogas sludge and construction and demolition waste (C&D Waste) crushed material to watch the changes seen within the soil consistency, CBR values.
- To find out optimum percentages of materials used.

2. LITERATURE REVIEW

V. Ramesh Babu, K. Niveditha, Dr. B. Ramesh Babu studied the stabilization of black cotton soil by using sand and cement mixture. during this research work, sand is added 10% and cement is added 2% up to 30% to the expansive soil at the interval of 10%. The black cotton soil was derived from chintakommadinne area. Different index and engineering properties were acknowledged and optimum percentages of mixes were searched. they need found the decrease in plastic limit, liquid limit and OMC and increase in MDD. the utmost MDD obtained at 30% sand-2Îment combination. Similarly CBR value was optimum at 30% sand-2% cement.

Ashkan GHolipoor Norozi , Siavash Kouravand , Mohammad Boveiri reviewed the stabilization of soil and different waste materials used for it. From the review it had been observed that mostly used materials were cement, sand , lime, fly ash. they will be use effectively for expansive soils for the applications of lower layers of road pavement, fill material, dike material, and reclamation material. Agricultural waste like rice husk ash with combination of cement and lime are often used. they need found contribution of fibre in increasing strength.

Maninder Singh, Rubel Sharma, Abhishek studied the Soil stabilization using industrial waste (wheat husk and sugarcane straw ash). they need used the mixture of wheat husk ash and sugarcane sludge ash to obtained synergic effect by replacing ternary blends of WHA and SCSA ratios like (3+3%), (5+5%), (9 +9%), (7+7%) and (11+11%).The mixed sample was then used for performing the varied tests. they need found optimum result at the share of seven .

Vivek S, Parimal Kumar, Vivek Shukla, Kiran Markal ,Mallikarjun studied Stabilization of expansive soils using construction and demolition waste, Department of engineering , JSSATE, Bangalore, Karnataka, India.: this work deals with the alteration of BC soil using Construction and Demolition (C & D) waste (concrete and plastering debris) which resulted in soil+10 percent C & D waste optimum mix obtained through standard proctor test. Further, the cohesion (c) and angle of internal friction (ϕ) were evaluated using Direct Shear test and therefore the Safe Bearing Capacity (SBC) of soil was calculated using Terzaghi's equation for BC soil alone, BC+10 C&D & D, BC + 12 C & D and BC + 14 % C & D waste respectively. within the experimental studies, it often seen that optimum addition of C & D waste can efficiently contribute in decreasing the swelling characteristics of black cotton soil by transmitting high bearing capacity and strength and may be contemplated as a substitute stabilizer which reinforces the utilization of waste obtained from construction industry.

M. Chittaranjan, M. Vijay, D. Keerthi researched the 'Agricultural wastes as soil stabilizers'. In this study Agricultural wastes such as sugar cane bagasse ash, rice husk ash and groundnut shell ash used to stabilize the weak sub grade soil. The weak sub grade soil was stabilized with the above wastes separately at 0%, 3%, 6%, 9%, 12% and 15% and CBR test is carried out for each per cent .The results of these tests improved CBR value with the increase in percentage of waste.

Likhitha.H, Raghavendra.H.N, Rakesh.K.P., Uday Shrihari.P Global Academy of Technology investigated the 'Stabilization of Subgrade Black Cotton Soil using Cement and M- Sand'. The authors have carried out investigation on changing in properties of black cotton soil using Msand and cement with varying percentage of 10, 20 for M-sand and 2% for cement. The study has carried out on proctor test, CBR test. The researcher concluded that these stabilizers can be used effectively for sub grade black cotton soil.

S. Dhananjaya, Tushar G. Warade, Ankit S. Wankhede, Shubham N. Raghuvanshi, Kishor H. Tandale investigated 'Stabilization of Black Cotton Soil by Using Construction and Demolition Waste'. Researchers found the improvements in characteristics of soil by adding C&D waste varied from 3, 6, and 9% and concluded that as C&D amount increases the CBR value of soil increases and can be used for stabilisation.

3. TESTING METHODOLOGY

In this experimental works all tests were carried out according to IS standards given. All procedures were followed to obtained the results. The IS codes referred for different tests is shown in Table 3.1.

Table 3.1: List of test standards used

Sr. No.	Laboratory tests	Is codes
1	Plastic limit	IS 2720 part 5-1987
2 3	Specific gravity test	IS 2780 part 3-1987
4	Liquid limit Sieve analysis	IS 2720 part 5-1987 IS 2720 part 4-1987
5	Standard proctor test	IS 2720 part 7-1987
6	CBR	IS 2720 part 16-1987

4. EXPERIMENTAL PROGRAM

4.1 Materials

In this research paper two materials are used for stabilization. One is construction and demolition waste collected from different demolition sites. Its powdered form is ready by mechanical means for determination of plastic limit and liquid limit passing through 425 micron IS sieve. For conduction of proctor test and CBR test C&D waste gone through 20 mm IS sieve. Another material used is sludge which is collected from Sanjivani Sakhar Karkhana, Kopergaon Biogas plant. It was allowed to dry first using natural sun rays then used as stabilizing material. To avoid absorption of moisture it's packed in plastic bags.

4.1.1 Materials collection and preparation-

a) Soil 1- Black cotton soil
Black cotton soil was collected from land located in Puntamba village Dist. - Ahmednagar near railway station. Soil was gathered by digging the hole up to 1 m removing any branches, plants root, boulders, rocks etc. and allowed to sun dried for 2 days to volatile any moisture content and stored in bag at dry place. It is then passed through 425 micron IS sieve for conducting plastic limit, liquid limit tests and passing through 20 mm for CBR test.

Figure 1 – Black Cotton Soil

b) Materials –

Material 1- Construction and demolition

Construction and demolition waste is collected from different demolition places of Kopergaon Taluka, Dist- Ahmednagar. It was prepared in the form of powdered by crushing with the help of hammer and machines by giving impact to boulder size material. It was then passed through 425 micron and 20 mm for determination of plastic limit liquid limit and CBR test.

Material 2- Sludge

Sludge is collected from Sugarcane Biogas plant of Sanjivani Sakhar Karkhana, Kopergaon. It was sun dried first and then powdered for carrying out plastic limit and liquid limit test by passing through 425 micron IS sieve.

Figure 3- Crushed C&D waste

Figure 4- Dried sludge

4.2 Method of testing

All the tests were conducted with regard to IS code and MORTH. Standard compaction test were administered on black cotton soil using two materials i.e. construction and demolition waste and sludge. These two materials added in soil with varying percentages of 0, 5, 10, and 15 and obtained the optimum value of maximum dry density and optimum moisture content for conduction of CBR test. The variation of plastic limit and liquid limit of black cotton soil is additionally studied with varying percentage of C&D waste and sludge. The CBR test is administered for un-soaked and soak condition. The mixture was collected in standard CBR mould of fifty mm diameter and therefore the value of CBR has acknowledged at the penetration rate 1.25mm/sec.

4.2.1. Methods-

In this research paper lab testing's have conducted for evaluation of materials effect on varying percentage to stabilize black cotton soil and lateritic soil. In this paper two materials were used i.e. construction and demolition waste and sludge waste. These two materials were added in these two soils from 0, 5, 10 and 15 % and found out plastic limit, liquid limit, MDD, OMC and CBR.

This investigation was carried out in two stages-

In the first stage the index properties and engineering properties of black cotton soil has found out.

In second stage following work has carried out:

1. While adding C&D waste and sludge it was thoroughly mixed with black cotton soil before conduction of practical by hand mixing wearing gloves to avoid absorption or evaporation of any moisture.
2. Finding Plastic limit by adding C&D waste and sludge (0, 5, 10, and 15%) in black cotton soil
3. Finding out liquid limit by varying percentages of C&D waste and sludge.
4. After finding plastic limit and liquid limit, MDD and OMC had found out using standard proctor test.
5. CBR test has carried out after finding optimum moisture content corresponding to maximum dry density for 0,5,10 & 15 percentages of variation.

5. RESULTS AND DISCUSSIONS

5.1 Experimental investigation on soil sample

Stage 1 result- Properties of black cotton soil

Table -5.1: Properties of black cotton soil

Sr. No.	Properties	Value of BC soil
1	FSI	54%
2	Specific gravity	2.419
3	Atterberg's limit Liquid limit Plastic limit Plasticity index	 57.20% 27.22% 29.98%
4	Grain size analysis Sand	 17%

	Silt	83%
5	IS classification of soil	CH
6	Compaction parameters MDD OMC	 1.42 gm/cc 30.32%
7	CBR value	4.24

5.2 Atterberg's limit tests

The variation of plastic limit and liquid limit is given in Figure 1. The plastic limit of untreated black cotton soil was observed to be reducing after addition of C&D waste. It was observed that the decreasing rate of plastic limit was more in case of addition of C&D waste in regard with sludge waste. This decrement is due to addition of cementitious material i.e. C&D which evaporate the water due to heat of hydration, as it accommodate cement. Liquid limit was also observed to fall varyingly when C&D waste and sludge added in to the black cotton soil. It was observed that up to 23% and 10% reduction in the plastic limit after addition of 15% C&D waste and sludge respectively. The liquid limit is lowered to 24% and 9% after addition of 15% of C&D and sludge waste.

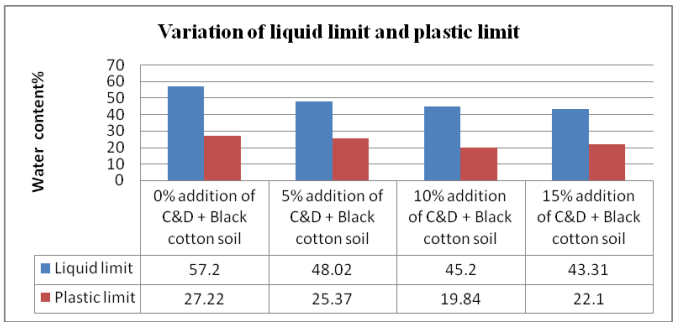

Fig. 5.1: Variation of Plastic Limit and Liquid Limit of Black Cotton Soil after Addition of Varying Percentage of C&D Waste.

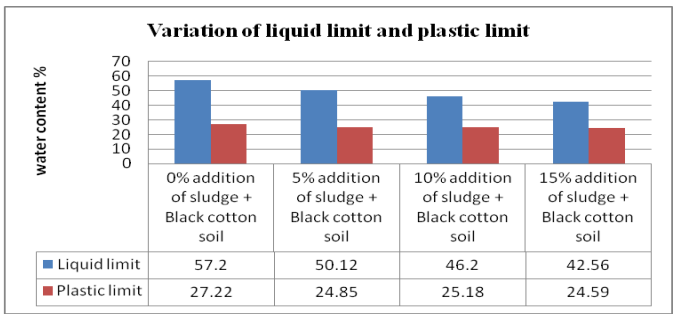

Fig. 5.2: Variation Of Plastic Limit And Liquid Limit Of Black Cotton Soil After Addition Of Varying Percentage Of Sludge Waste.

5.3 Compression test

The MDD and OMC have administered using standard proctor test with light compaction (hammer weight 2.6 kg). The C&D waste and sludge added in to the black cotton soil manually and mixing thoroughly to induce proper distribution of material into soil. The spatula is employed for correct mixing of materials to avoid moisture absorption. then whole 5 kg sample were filled into the standard proctor mould in to 3 layers by giving 25 numbers of blows to every layer. The procedure followed as per given in IS 2720- Part 7-1987. The compaction test was applied for various percentage of C&D waste and sludge. the subsequent results were obtained for the share of 5, 10, 15 of C&D and sludge waste.

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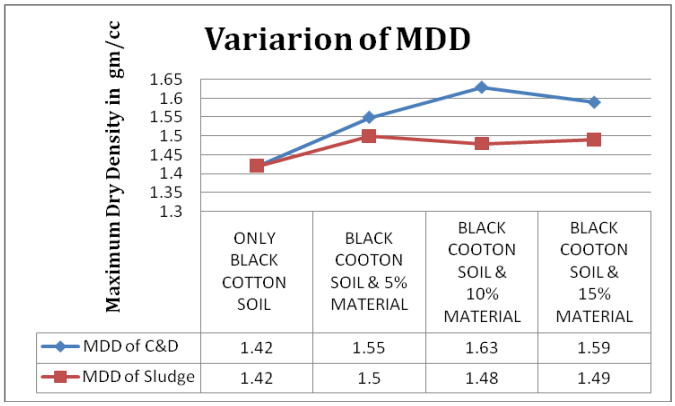

Fig. 5.3: Variation of MDD of Black Cotton Soil after Addition of Varying Percentage of C&D and Sludge Waste.

The graphs shown in fig. 5.3 and 5.4 shows the variation of MDD and OMC. It was observed that when C&D waste added into the black cotton soil, the values of MDD go on increasing. The MDD has found to increase in case of C&D up to 14.78% and for sludge it was observed to be increased to 5.63%.

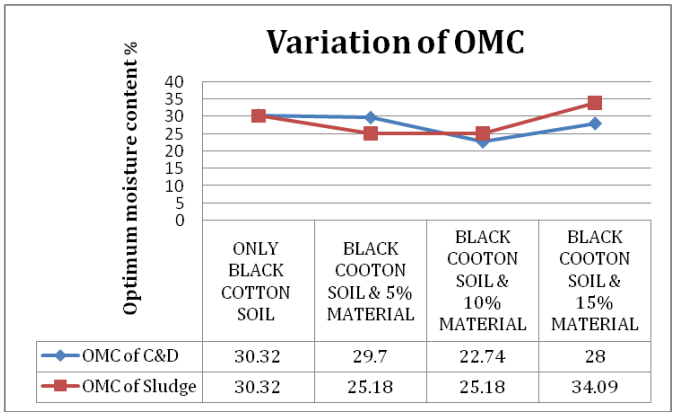

Fig. 5.4: Variation of OMC of Black Cotton Soil after Addition of Varying Percentage of C&D and Sludge Waste.

It was observed that the MDD varyingly increase with addition of sludge waste. The maximum value of MDD obtained at 5% addition of sludge waste. Where, OMC variation is given in figure number 5.3. When sludge added to OMC first decrease and then increase with addition of 15% sludge. It was due to increasing the clay material of both sludge and soil which absorb the water content and hence decrease the MDD value. C&D waste when added in soil, the moisture requirement reduces due to decreasing the volume of fine particles of black cotton soil. Hence MDD increases due to gaps were filled by the soil fractions. The MDD was observed high at 10% addition of C&D waste and then it is decrease due to decrease in OMC value.

5.4 California Bearing Ratio test

CBR test was carried out for soaked and un-soaked condition. The C&D waste gives good result for black cotton soil as compared to sludge. Both the materials increase the CBR value of black cotton soil at certain limit. It is observed that CBR value was more at addition of 10% of C&D waste while it was high at 5% of sludge is added in to soil. Figure 5 and 6 gives variation of CBR values.

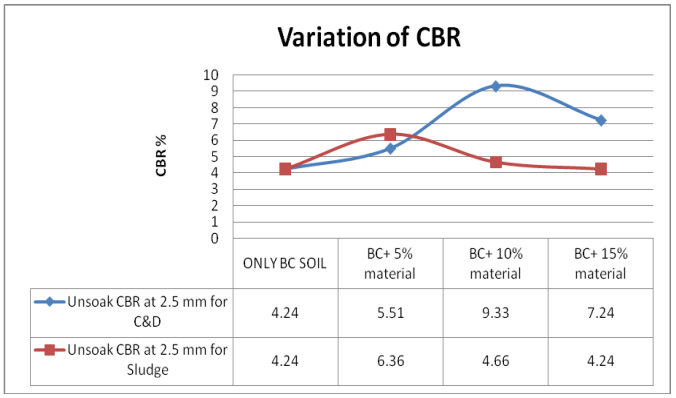

Fig. 5.5: Variation of CBR value for un-soak condition of Black Cotton Soil after Addition of Varying Percentage of Sludge Waste.

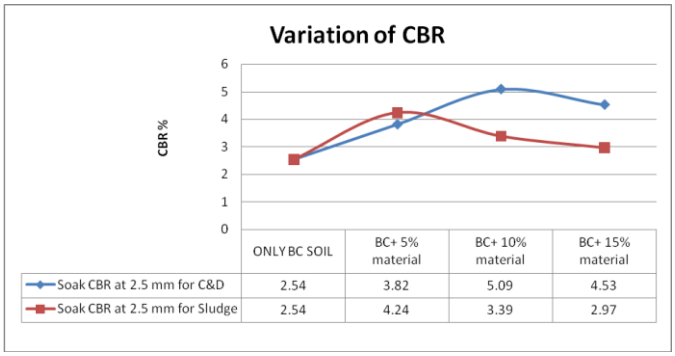

Fig. 5.6: Variation Of CBR value for soak condition (96 hours) of Black Cotton Soil after Addition Of Varying Percentage Of Sludge Waste.

The CBR value variation was varied for both the material. The C&D waste has given good result as compared to sludge waste. The maximum CBR value for C&D waste is obtained at the percentage of 10 while for sludge it was found at 5%. The CBR value of untreated black cotton soil has increased to 14.78% after treatment. For sludge the CBR value rises to 36.48%. The CBR value shows differentiation with addition of material with increase in percentage of material.

6. CONCLUSION

The concluding points from the laboratory investigations of untreated soil and treated soil are as follows:

- The plastic limit and liquid limit of untreated soil has found 57.2% and 27.22% which was very high express highly unstable for construction without treatment.
- The MDD and OMC of untreated soil found to be very poor as compared to treated soil.
- C&D waste gives optimum MDD with the addition of 10% C&D waste. The value of MDD has improved by 14.78%.
- Sludge waste gives optimum MDD with the addition of 5% sludge waste. The value of MDD has enhanced
- CBR value of untreated soil was 4.24 which is less proves effectively by using C&D waste by addition of 10% C&D waste.
- CBR value of untreated soil was improved by using sludge waste by addition of 5% sludge waste.
- The C&D waste gives maximum CBR as regard to sludge. So we can utilize both the materials for stabilization of soil up to certain limit.

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