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Assessment of Black Cotton Soil by Use of Ceramic Dust, RBI Grade 81 and Lime

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Abstract: This paper presents the effect of RBI GRADE 81, LIME & CERAMIC DUST. The various properties of soil like liquid limit, plastic limit, unconfined compressive strength, compaction characteristics, California bearing ratio and swelling pressure of an expansive soil. Black cotton soil collected locally was blended with different percentage of stabilizer according to the previous research which is conducted on individual stabilizer. From the analysis of test result, it was observed that plastic limit, liquid limit, plasticity index, swelling pressure and optimum moisture content of soil decreases. Maximum dry density, unconfined compressive strength and California bearing ratio increased with the percentage increase of stabilizer (lime, ceramic dust, RBI grade 81). As an effective analysis It was founded that on comparison of above three stabilizer RBI grade 81 gives better result between 3% to 6% addition to the soil can be used in enhancement of soil properties.

Keywords: Black Cotton soil, RBI grade 81, lime, ceramic dust, CBR value, compaction value, UCS.

I. INTRODUCTION

In the dense population country like India 1.38 billion (approx.). At an area of 32,85,239 sq.km. less land remains or construction due to increase of urbanisation. Land is used for different purpose and structure from a simple building to skyscraper, flyover to airport and from rural road to expressway.

Soil is cheap and easily transportable construction material in the field of civil engineering. But due to its poor properties in the field of engineering it's needs to be stabilized by different method of stabilization. Low properties of soil provide insufficient strength to bear the load imposed on its at its useful life. Availability of soil at different places have varies its properties which required to be stabilized according to type of construction.

Recently new techniques are developed to stabilised the soil, new polymer stabilizer RBI GRADE-81 , CERAMIC DUST and LIME is an innovative material product to stabilized the soil these are environment friendly powder based stabilizer & increases the property of soil at the optimum level ,different techniques improve the properties of soil but shows the variation at different percentage when added in soil. Main concert in the stabilization is greater stability with less cost of material. And material is eco-friendly and durable.

II. PROBLEM STATEMENT

All the above mention detail about black cotton soil we can conclude that soil need to be stabilised for used in any type of construction. Improvement in the properties of soil can be done by any of waste material there on the basis of usability & transportability of waste material.

By use of different waste material different changes in properties of soil may observed. Soil stabilization become necessary & should be tested in the laboratory. before get applied on the field. There is attempt done to improve the properties of soil by means of ceramic dust, lime & RBI Grade 81 their result gets compared which give idea about economical & efficient mode to stabilized the soil.

III. OBJECTIVE OF THE STUDY

- A. To study the effect of different percentages of ceramic dust, lime & RBI GRADE 81 on Atterberg's limits (Liquid limit, Plastic limit) and Differential free swell (DFS).
- B. To study the effect of varying percentages of ceramic dust, lime and RBI GRADE 81 on Compaction characteristics (OMC & MDD), Unconfined compressive strength (UCS) and California bearing ratio (CBR).
- C. To compare an optimum percentage of ceramic dust, lime & RBI GRADE 81 that can be used with B.C SOIL.
- D. Defining the range of different properties of soil on the basis of above comparative work.

IV. RESEARCH METHODOLOGY

The above objective can be achieved by following steps

- 1) Step 1. Properties of stabilizer used in study.
- 2) Step 2. Properties of black cotton soil.
- 3) Step 3. Addition of various proportion of stabilizer in soil.
- 4) Step 4. Analysis of Enhancement of various properties of black cotton soil.
- 5) Step 5. Comparison of various test result on black cotton soil.
- 6) Step 6. Analysis of Result.
- 7) Step 7. Conclusion and Recommendation.

V. PROPERTIES OF STABILIZERS: - RBI GRADE 81, LIME, CERAMIC DUST

RBI grade 81 appears to be Beige powder in nature having pH value of 12.5 (saturated paste) and having specific gravity of 2.5.

Solubility of Rbi grade 81 in water is 0.2pts/100pts and It is a basic material, not acidic. Use exhaust ventilation to maintain dust levels below exposure limits in workplaces with poor ventilation and dusty conditions, storage temperature and pressure in unlimited, stored at dry place away from the water.

Summary of the starting hydration reaction are as follows:

- A. Add on of water initially hydrate all RBI GRADE-81 components,
- B. Lime mix dissipation creates excess Ca-ions and OH-ions,
- C. OH-ions rises the pH of the soil, in so doing activating the pH contingent sites on clays,
- D. Ca-ions interact with commutable and pH contingent sites on clays, forming calcium silicates and calcium aluminates hydration products,
- E. Hydration of calcium is very fast,
- F. Calcium at sites will form nucleation to cast the soil particles into a merged matrix,
- G. Ca-ions from the specified cement mix hydration, along with Ca-ions from the lime mix hydrated, will turn on the slang component,
- H. C3A initiate the hydration,
- I. Calcite formation will be restricted due to the reduction in nature of porosity,
- J. Initial reaction will be ended up with the final setting time of the lime mix approximately 120 minutes from a add on of water.

Ceramic dust is inorganic, non-metallic crystalline solid material make ready by heating and successive cooling. Today various types of ceramic materials are being used in the construction industry as well as in household works. Broken vitrified tiles are progressively used in the construction industry to meet the stabilizer requirements. Ceramic dust has higher level properties than natural stone dust and other types of tiles material. The basis material used for preparation of ceramic tiles consists of clay minerals and chemical additives. Waste ceramic tiles from tiles industries were broken into small pieces by hammer and crushed into powder form by automatic compactor. The crushed ceramic material was passed through 425 microns IS sieve. After sieving is done the ceramic dust has been used in the experimental works.

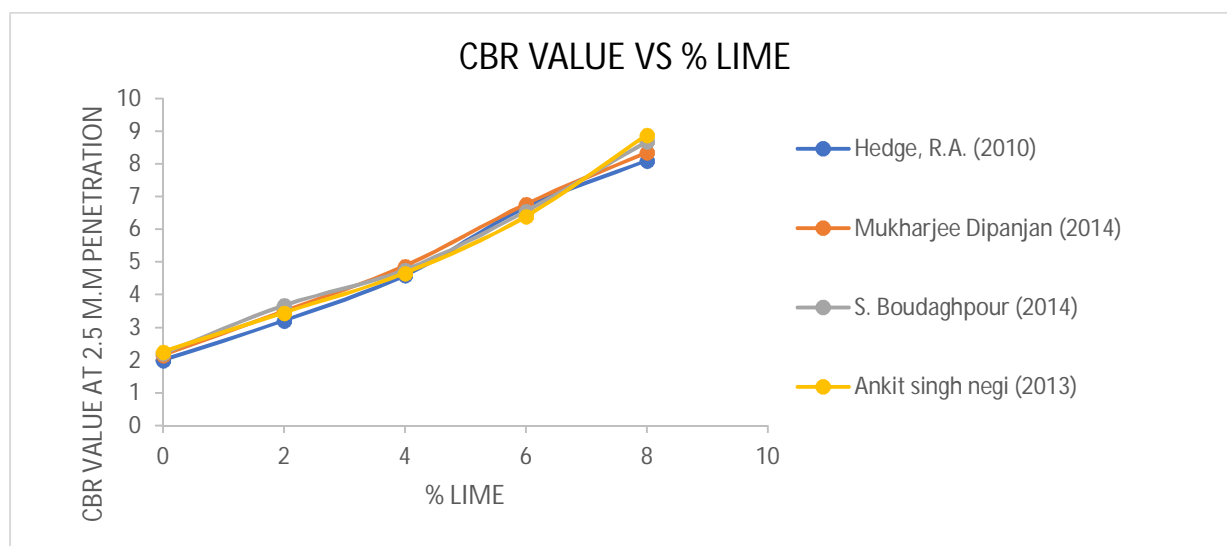
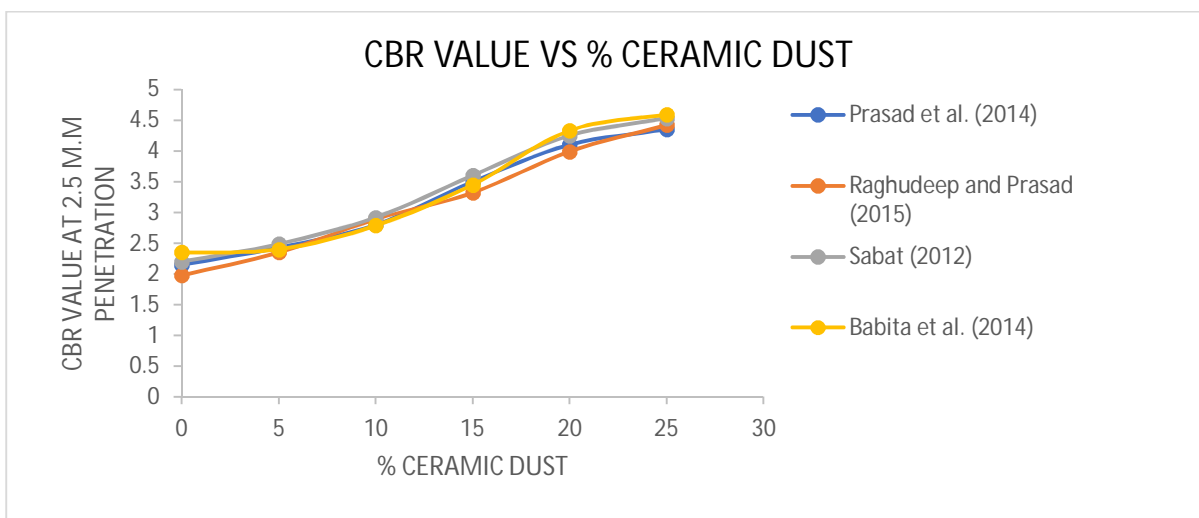
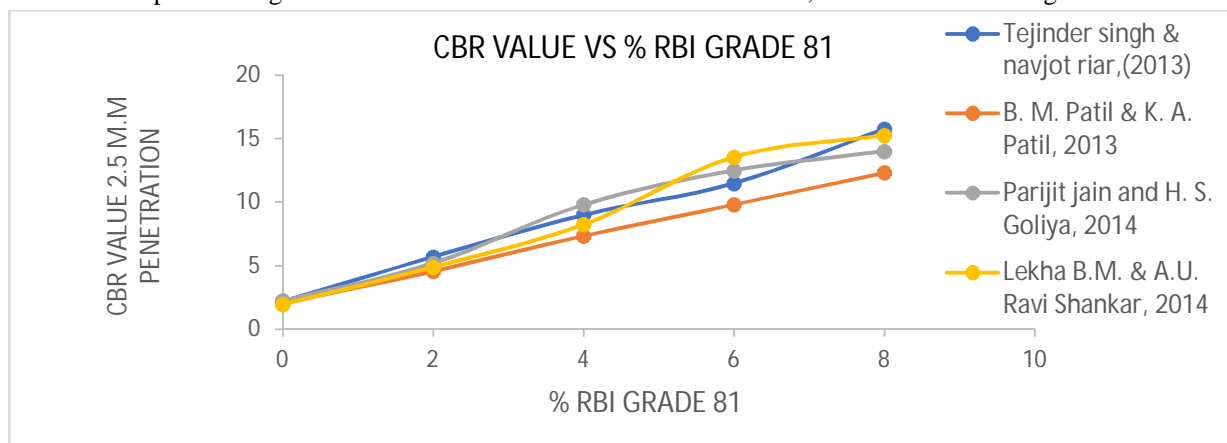
Limestone appears to be yellow, white or grey in nature. It is a sedimentary rock having chemical composition of calcite (>50%), texture is clastic or non-clastic and generally hard. Limestone get crushed into powder form to use as stabilizer which is called as lime stabilization. Lime having pH value of 11-13, specific gravity of 2.65 to 3.0, bulk density (g/cm³) 0.7-1.1

VI. PROPERTIES OF BLACK COTTON SOIL

Black cotton soil appears to be black colour & expansive in nature. It is founded in in many parts of state like m p, u.p, Tamil Nadu & Telangana. black cotton soil is having clay mineral montmorillonite which provide swelling & shrinkage to the soil with change in moisture content soil exhibits different properties. Liquid limit from 50-95 & plasticity index from 15-55 & another one shrinkage limit from 5-20 %. these all properties depend on moisture content. they possess low strength & low bearing capacity. B.C soil possess high swelling & shrinkage which make them not suitable for pavement construction. Heavy damage may occur after each monsoon season. these are seen in terms of ruts differential settlement pot holes & cracks in the rigid pavement.

VII. COMPARISON OF CBR VALUE AT DIFFERENT % OF LIME, CERAMIC DUST AND RBI GRADE 81: -

Graph Showing Variation of CBR value with different % of lime, ceramic dust and rbi grade 81



UCS VALUES Range (KN/m²)

| RBI GRADE-81 PROPORTIONS (%) | UCS VALUE (kN/m ²) |
|---------------------------------|-----------------------------------|
| • 0 | • 131-135 |
| • 2 | • 165-168 |
| • 4 | • 248-251 |
| • 6 | • 393-396 |
| • 8 | • 576-590 |

| LIME PROPORTION (%) | UCS VALUE (KN/m ²) |
|------------------------|--------------------------------|
| • 0 | • 123-126 |
| • 2 | • 174-177 |
| • 4 | • 253-256 |
| • 6 | • 353-357 |
| • 8 | • 432-440 |

| CERAMIC DUST PROPORTION (%) | UNCONFINED COMPRESSIVE STRENGTH (KN/m ²) |
|-----------------------------------|---|
| • 0 | • 57.3 -59.7 |
| • 5 | • 61.2-64.7 |
| • 10 | • 70.6-73.6 |
| • 15 | • 82.3-85.4 |
| • 20 | • 89.7-92.2 |
| • 25 | • 96.8-110 |

DFS VALUE Ranges (%)

| RBI GRADE 81 PROPORTION (%) | DFS (%) |
|-----------------------------------|---------|
| • 00 | • 62-66 |
| • 02 | • 41-48 |
| • 04 | • 31-37 |
| • 06 | • 27-30 |
| • 08 | • 21-26 |

| LIME PROPORTION (%) | DFS (%) |
|------------------------|---------|
| • 00 | • 60-68 |
| • 02 | • 40-48 |
| • 04 | • 33-39 |
| • 06 | • 28-32 |
| • 08 | • 22-27 |

| Ceramic dust PROPORTION (%) | DFS (%) |
|-----------------------------------|---------|
| • 00 | • 63-68 |
| • 05 | • 59-62 |
| • 10 | • 51-58 |
| • 15 | • 41-48 |
| • 20 | • 30-38 |
| • 25 | • 22-29 |

VIII. CONCLUSION

It can be observed from the different literature reviews that test results gives better in RBI Grade-81 than the lime and ceramic dust, hence RBI grade 81 is very effective in enhancing the California Bearing Ratio (CBR) value. The CBR value of the soil raised with increment in proportion of RBI Grade-81 from 0% to 8% and with increasing in duration of curing periods from 0 days to 24 days. Possible reason of CBR increment is formation of inter-particle bond and crystal matrix because of the reaction of RBI Grade-81 with the native soil particles. The maximum increment in CBR value is observed at 8% of RBI Grade-81 and after 24 days curing and four days soaking. The value of CBR of native soil was 2.19% which is increased to 15.64 at 8% RBI and after 28 days. Thus, it can be concluded that RBI grade-81 is very effective in enhancement of the CBR value of the soil than the lime and ceramic dust.

IX. FUTURE RECOMMENDATIONS

There is a huge scope for research work in the future with lime, ceramic and RBI Grade-81. Rbi grade 81 is efficient, environment-friendly, long-lasting and effectively improve the engineering properties of soil. It can be used with all type of soils. It is a newly developed stabilizer which come to India in 2008 and becoming popular from the beginning as compare to other stabilizers like lime and ceramic dust. Indian army (BRO) is continuously using this material from 2009. No proper code is available for this stabilizer for use with different type of soils. Some of areas in which research can be done in the future are: -

- A. Various waste materials like plastic waste, quarry waste which has problems of dumping and recycling. A study can be carried out on the stabilization of soil by using various waste materials with RBI Grade-81, lime and ceramic dust combination. It will be effective and environment-friendly.
- B. Stone dust and brick dust can also be mixed with lime, ceramic dust and Rbi grade 81. Evaluation of different properties of soil can be done with different proportion of material.
- C. A study can be carried out on the stabilization of black cotton soil using waste material like demolition waste, all types of slag, marble, granite, stone dust, fly ash, etc. and used in road construction.

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