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International Journal For Research in  
Applied Science and Engineering Technology



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# **INTERNATIONAL JOURNAL FOR RESEARCH**

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

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**Volume: 8      Issue: II      Month of publication: February 2020**

**DOI: <http://doi.org/10.22214/ijraset.2020.2093>**

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# Assessment and Strengthening of Black Cotton Soil by using RBI Grade-81, Rice Husk Powder & Lime

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**Abstract:** *Expansive soils pose a detrimental for any construction that rest upon this soil. This paper presents a comparative study of different additives on the index properties of expansive soils. Three additives are used. One is RBI grade 81, and two others are lime and rice husk powder. A laboratory study consisted of the following tests on samples treated with stabilizer: Liquid Limit, Plastic Limit & Plasticity Index. It has found that the liquid limits as well as Plasticity Index decreases and plastic limit increases by increasing the proportions of RBI Grade 81, Rice husk powder and lime. At 8% RBI grade-81, 5% Rice Husk powder and 6% Lime the LL is 44 %, PL is 25.21% and PI is 19.07%*

**Keywords:** *Black Cotton soil, LL, PL, PI, LIME, RBI-81, Rice Husk Powder.*

## I. INTRODUCTION

Black cotton soils are inorganic clays of medium to high compressibility and form a major soil group in India. They are characterized by high shrinkage and swelling properties. This Black cotton soils occurs mostly in the central and western parts and covers approximately 20% of the total area of India. Because of its high swelling and shrinkage characteristics, the Black cotton soils (BC soils) has been a challenge to the highway engineers. The Black cotton soil is very hard when dry, but loses its strength completely when in wet condition. The development of cracks in dried Black cotton soil and loss of strength of on wetting causes failure of pavement. To overcome all these problems different methods of treatment are used and also different materials or additives are also used for black cotton soils. In the present study Lime, Rice Husk Powder and RBI Grade 81 were used in different proportions with Black Cotton Soil.

## II. MATERIALS

### A. Black Cotton Soil

The black cotton soil used in this study is a highly plastic clayey soil having high swelling nature and is proved to be very problematic for the construction of various infrastructures like pavements, foundation, etc. The black cotton soils contain the Montmorillonite as a clay mineral, which causes the swelling nature in soil, due to water bond between the particles of soil. In India, the black cotton soil is available in about 20 - 25% land area, which includes major portion of Madhya Pradesh India. The alternate swell and shrink in the black cotton soil, due to wet and dry season, causes the differential settlement in the structure founded on them. This results the structural damage of the structures in the form of micro cracks on its surfaces.

In the present study black cotton soil was obtained in sacks from Misrod area of district Bhopal, Madhya Pradesh for Experimental use in laboratory. The various geotechnical properties of the Black Cotton Soil shown in **Table 1**

### B. RBI Grade-81

RBI Grade-81 is an advanced, cost effective and environmentally beneficial technological breakthrough in soil stabilization. RBI Grade-81 is a cementitious stabilizer that improves the engineering properties of soil. This technology was internationally coordinated by Road Building International since 1990 hence the name RBI Grade-81. RBI grade-81 was obtained from Bansal Engineering College, Bhopal Madhya Pradesh. Physical properties and chemical composition of RBI grade-81 are shown in Table II & III.

### C. Lime

Lime is one of the basic building materials used mainly as lime mortar in construction. Properties of building lime, advantages, and uses in construction are discussed. The broad category of lime is non-hydraulic and hydraulic lime. The non-hydraulic lime is called as quick lime, fat lime or white lime or as lump lime. Hydraulic lime sets under water and non-hydraulic lime do not set under water. Quick Lime is a form of lime is manufactured by the burning of stone that has calcium carbonate within it. The burning temperature varies, say 900 degree Celsius and above for several hours. This process is called as calcination. The solid product that remain after the removal of carbon dioxide in the calcium carbonate is called as the quicklime. . Physical properties and chemical composition of Lime are shown in Table IV & V.

### D. Rice Husk Powder (RHP)

Rice husks have been attracted as value added material towards waste utilization and cost reduction in domestic and industrial processing. Rice husk (RH) is widely available in rice producing countries like China and India which contributes 33% and 22% of global rice production respectively, as by-product of the rice milling. RH content ranges from 16-25% of paddy (Della *et al.*, 2002; Giddelet *et al.*, 2007; Soltaniet *et al.*, 2015). Every year approximately 600 million tons paddy produced by world and 120 million tons of paddy produced by India, it gives around 24 million tons of RH per year (Shwethaet *et al.*, 2014). Rice husk POWDER (RHP) is the by-product of RH. 20 million tons produced per year by world (Koteswara and Pranav, 2011; Soltaniet *et al.*, 2015). Due to low density and less commercial interest of RH, handling as well as transportation it is problematic, which creates disposal and serious environmental problems. . Physical properties and chemical composition of Rice Husk Powder are shown in Table VI&VII.

TABLE I

S.No.	Properties	Range	Code referred
1	Specific Gravity	2.64	IS 2720 (Part 3) - 1980
2	Maximum Dry Density (MDD)	1.75gm/cc	IS 2720 (Part 7) - 1980
3	Optimum Moisture Content (OMC)	18.9 %	IS 2720 (Part 7) - 1980
4	Free Swell Index	48.54%	IS 2720 (Part 40) - 1977
5	Liquid Limit	52%	IS 2720 (Part 5) - 1985
6	Plastic Limit	24%	IS 2720 (Part 5) - 1985
7	Plasticity Index	28%	IS 2720 (Part 5) - 1985
8	Shrinkage Limit	12.26%	IS 2720 (Part 6) - 1985

TABLE II

Physical Properties	RBI Grade -81
Odour	Odourless
PH	12.5
Freezing point	None
Flammability	Non-flammable
Shelf life	12 months
Storage	Dry storage
Bulk density	700 kg/m <sup>3</sup>

Table III Chemical Composition of RBI Grade 81

PROPERTIES	% BY MASS
Calcium Oxide (CaO)	52-56 %
Sulphur Trioxide	9-11 %
Silicon Dioxide	15-19 %
Aluminum Oxide	5-7 %
Iron Oxide	0-2 %
Magnesium Oxide (MgO)	0-1 %
Fibers (polypropylene)	0-1 %
Additives	0-4 %

Table IV Physical Properties of Lime

S.No	Characteristics	Value
1.	Water Absorptipn	0.6%
2.	Specific Gravity	2.75
3.	Fineness by wet sieving retain on 12.5 micron	0.59%

Table V Chemical Composition of Lime

S.NO	CHARACTERISTICS	VALUE
1.	Lime	38-42%
2.	Silica	15-18%
3.	Alumunium	3-5%
4.	Mgo	0.5-3%
5.	Feo	1-1.5%
6.	Loss on ignition	3.-32%

Table VI Physical Properties of Rice Husk Powder

S.NO	Particulars	Properties
1.	Colour	Yellowish
2.	Shape texture	Irregular
3.	Mineralogy	Non crystalline
4.	Particle size	<80 micron
5.	Odour	Odourless
6.	Specific gravity	1.8
7.	Appearance	Very fine

Table VII Chemical Composition of Rice Husk Powder

S.NO	particulars	Proportion
1.	Carbon	39.8-41.1 %
2.	Hydrogen	5.7-6.1 %
3.	Oxygen	0.5-0.6 %
4.	Nitrogen	37.4-36.6 %
5.	Silica	28-30%

### III.EXPERIMENTAL STUDY

#### A. Preparation Of Samples

The soil samples shall be dried before conducting tests. Before drying, the clods were broken to hasten drying. The organic matters like leaves and roots were also removed from the sample. The wet sample were dried in oven at controlled temperature of 105 - 115°C. Black cotton soil was stabilized by adding RBI Grade-81 (5%, 6%,7%, 8% and 9%), Lime and Rice husk powder (4%, 5%, 6% and 7%) with dry weight of Black Cotton Soil.

#### B. Index Properties Tests

The various laboratory tests which are conducted to determine the effect of Lime, Rice Husk Powder and RBI Grade-81 on Black cotton soil are explained below. The tests are performed according to SP 36(Part 1)-1987: The compendium of Indian standards on soil engineering. The samples were subjected to Liquid limit test and plastic limit tests.

#### C. Liquid Limit Test

Liquid limit is the minimum water content at which soil has a tendency to flow and same was determined by the casagrande apparatus. The air-dried samples were subjected to removal of organic matter like traces of tree stem and roots. 120 grams of Black cotton soil passed through 425 micron sieve moisturized with water and filled horizontally in the Casagrande apparatus was dispersed in two halves by using grooving tool. The handle of apparatus was rotated until the two cake cuts flow together for a distance of ½ inch when the standard liquid limit apparatus is dropped 25 times at a height of 10 mm at the rate 2 drops per second. Liquid limit at 25 blows is determined by plotting a 'flow curve' on a semi-log graph with no. Of blows as abscissa (log scale) and the water content as ordinate. The results of Liquid limit is shown in table VIII and Fig. I

#### D. Plastic Limit Test

The moisture content at which the soil has the lowest plasticity is called the plastic limit. The soil shows the properties of a semi-solid when the water content just less than that of plastic limit. Black cotton soil was passed though the 425 micron IS sieve. About 50 gram of sample is taken in an evaporating dish. It is mixed with water thoroughly and made a soil paste which was molded with hand. The water content at which the sample can be rolled into 3mm diameter thread without crumbling is taken as plastic limit. This water content is knows as plastic limit. The plastic limit was taken as the average of three values. The results of Plastic limit is shown in Table VIII and Fig. II



#### IV.RESULTS

Table VIII: Result of Liquid Limit, Plastic Limit and Plasticity Index Using RBI Grade-81, Rice husk powder & Lime at different proportions.

S.NO	Sample	Liquid limit	Plastic Limit	Plasticity index
R1	Soil Sample With 0 % Of( RBI GRADE 81,LIME & RICE HUSK POWDER)	51.9	22.91	28.99
R2	Soil Sample With 5% RBI grade-81, 5%Rice Husk powder and 4%Lime	47	22.50	24.50
R3	Soil Sample With 6% RBI grade-81, 5%Rice Husk powder and 5%Lime	51	23.26	27.26
R4	Soil Sample With 7% RBI grade-81, 6%Rice Husk powder and 5%Lime	50	24.11	25.89
R5	Soil Sample With 8% RBI grade-81, 5%Rice Husk powder and 6%Lime	44	25.21	18.79
R6	Soil Sample With At 9% RBI grade-81, 6%Rice Husk powder and 6%Lime	45	25.93	19.07

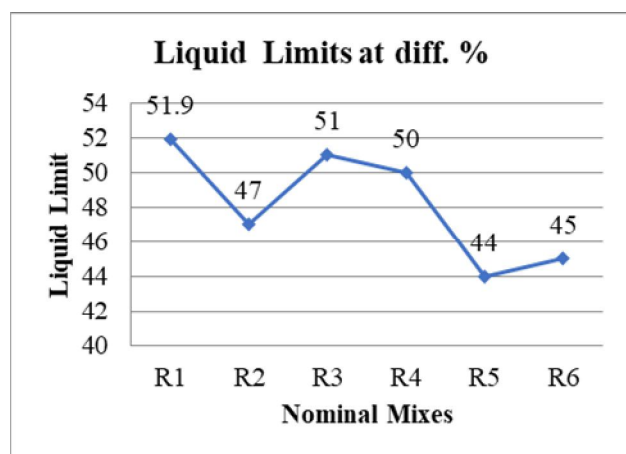


Fig. I Variation of Liquid Limit of Black cotton soil with RBI Grade-81,Rice Husk Powder & Lime

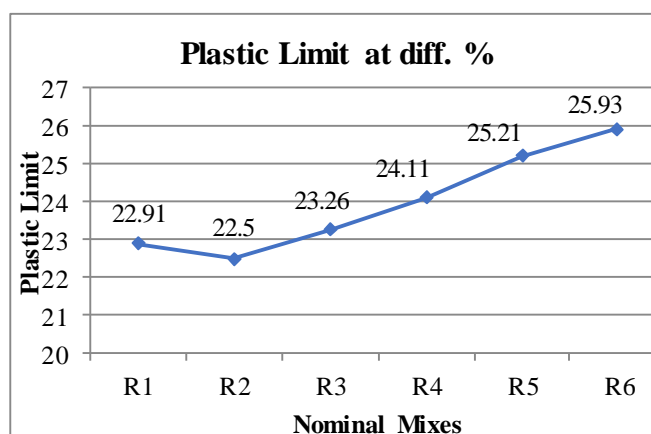


Fig. II Variation of Plastic Limit of Black cotton soil with RBI Grade-81,Rice Husk Powder & Lime

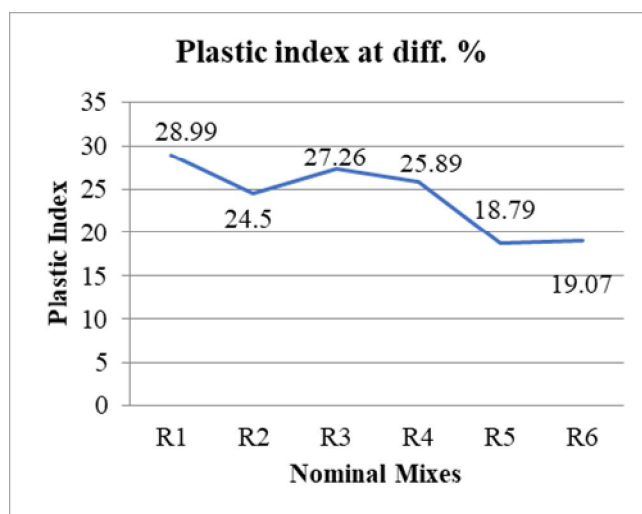


Fig.III Variation of Plasticity Index of Black cotton soil With RBI Grade-81, Rice Husk Powder and Lime.

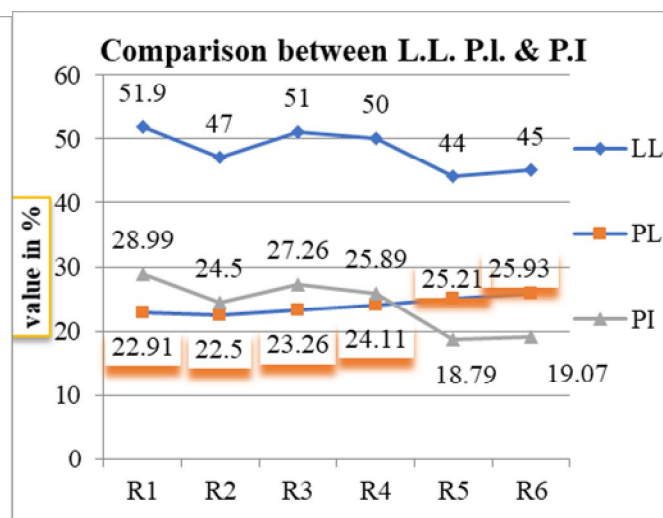


Fig. IV Comparison between L.L. P.L. & P.I of black cotton soil. at different nominal mixes

## V. CONCLUSION

Based on the results of this study the following conclusions may be drawn:

- A. Liquid Limit of the Black cotton Soil decreases with increase in percent of RBI Grade 81, Lime and Rice husk powder.
- B. Plastic Limit of Black cotton Soil increases with increase in percent of RBI Grade 81, lime and RHP.
- C. Plasticity Index of the Black cotton Soil decreases with increase in percent of RBI Grade 81 Lime and Rice husk powder.

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