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# Stabilization of Black Cotton Soil using RBI Grade 81 and Flyash

Gurunath K<sup>1</sup>, Nithin Somashekar D P<sup>2</sup>, Manu A<sup>3</sup>, Narasimha Murthy K N<sup>4</sup>, Prajwal K C<sup>5</sup>

<sup>1</sup>Asst Prof, <sup>2</sup>UG Students, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru

**Abstract:** Rapid development is going on in the construction industry. For the better and stable construction subgrade soil should have good strength to retain the upcoming load from the superstructure. Black cotton soil which is commonly found in many places is very weak in strength and it has the high-volume change properties for the environmental factors as it has high affinity towards water. As Black cotton soil consists of Montmorillonite mineral which has very weak bond and it shows high swelling and shrinking behaviour when it comes in contact with water. Black cotton soil needs to be replaced or these soils has to be stabilized for the construction purpose. For the stabilization's additives like RBI Grade 81 and Flyash are used to reduce the construction time and cost.

**Keywords:** Black Cotton Soil, RBI Grade 81, Fly ash, Stabilization.

## I. INTRODUCTION

Soil stabilization may be a method accustomed enhance the physical properties of the soil. Soil stabilization improves the shear strength of the soil and it management shrink-swell behaviour of soil. In India, Black cotton soil is found in the main in Maharashtra, Madhya Pradesh, province and Mysore. Developing countries like India expertise numerous challenges because of the presence of black cotton soil throughout the event of infrastructure comes. to enhance the subgrade, it's stable by mistreatment chemical additives or biopolymers. Strength and bearing capability of the soil is principally thought-about to transfer the masses to the below layers effectively with none failure. Therefore, to boost the specified properties of the soil it wants stabilization. In several sectors soil stabilization is employed particularly, roads, landfills, industries, slope protection, dam cores, etc

The different materials that square measure utilized in the development work ought to have enough strength and sturdiness to retain the wetting and drying condition, cooling and also thawing. durability can be explained as the material capacity to withstand its stability and the integrity over the years against destructive forces mainly weather. black cotton soil is not able to sustain for the wetting and drying condition as one of the environmental factors.

This project includes the study about RBI Grade 81 that is Road Building International Grade 81. It is in powder form and is inorganic in nature and it is added to Black cotton soil. The main reason of this study is to analyse the strength of soil when it is stabilized with Fly ash and RBI Grade 81 and to analyse the volume change properties after stabilization with various percentage of Fly ash and RBI Grade 81. Study is carried out to know the Free swell index (FSI) with different percentage of stabilizers. Durability studies are also carried out in this project.

## II. LITERATURE REVIEW

- A. S. Andavan "Volume Change Behaviour of Expansive Soils Stabilized with Recycles Ashes and Fibres" (may 2013, asce): in this paper, it is observed that lime and fly ash increase the strength of the soil after 7 and 28 days. by using the lime and fly ash there in increase in the density of the soil but the optimum lime to fly ash ratio is influenced in significant. these additives are not suitable for the sandy soil.
- B. Shao Li "Experimental Study on The Stabilization of Organic Clay with Fly Ash and Cement Mixed Method" (July 2013, asce) in their paper, they have concluded that the ucs of cement treated soil depends on the organic matters present in the soil. fly ash is good for the high organic content soil. in this paper the main conclusion is that the optimum value of the 12% of the fly ash content in terms of the long life. when there is increase in the fly ash content then there is increase in the shape factor and formation factor.
- C. T. Raghavendra "Engineering Properties of Controls Low Strength Material Using Fly Ash and Waste Gypsum Wall Boards" (Aug 2015, science direct) they have done the laboratory tests on the black cotton soil by using the fly ash and gypsum. in their paper, they have concluded that, to attend the full strength of the soil 28 days are required, strength of the soil is increases till 28 days, observed strength of the soil at 28 days is 0.36 to 3.49. they also have observed the strength and that the reduced value is 7% to 36% with respect to maximum value. if there is increase in gypsum content, then the demand of water will be more.

- D. Jaya Prakash Bab “Engineering Properties of Black Cotton Soil Modified with Fly Ash and Cement” (2016 IJETT): they have done the all-basic tests in this journal paper on the expensive soil mixed with fly ash at different percentage. in this they have concluded that we can make use on the treated expensive soil as a geo technical material by adding 6-10% of cement and 30-40% of fly ash. there is improvement in the properties like swelling, shrinkage, MDD and OMC.
- E. Alaka Sreedhar “Stabilization of Black Cotton Soil Using RBI Grade 81” (April 2017, IJCESR): he has done the study on the black cotton soil stabilization in which he has mainly focused on the CBR and UCS tests results. by observing the results from the tests, he has made the conclusion that we can use the stabilized soil for the construction of sub grade, sub base and base coarse. if there is increase in the dosage of RBI grade 81 then there is improvement in the CBR and also there is improvement in the ucs value.
- F. Kishore Kumar “Evaluation of RBI Grade 81 For Stabilization of Expansive Soil as Sub-Grade Material” (April 2017, science direct) they have concluded that the California bearing ratio (CBR) value depends on the curing period and percentage of RBI grade 81. they have obtained maximum CBR value as 19.54 at 28 days of curing period and at 4% of RBI grade 81. ucs will increase if there is increase in the RBI content. ucs is sufficient at 4% of RBI grade 81. there is a decrease in FSI with increase in the RBI content. the maximum dry density (MDD) is 1.850 g/cc and optimum moisture content (OMC) is 15.40% at the RBI content of 5%. MDD will increase with increase in RBI content. there is a decrease in the liquid limit with increase in the RBI content and plastic limit increases with increase in RBI content.
- G. Shiva Prashant Kumar Kodicherl “Effect of RBI Grade 81 On Strength Characteristics of Clayey Subgrade” (November 2017, international journal of geo engineering): they have studies about the effect of the RBI grade 81 on the soil regarding the strength of the soil. the outcomes of the tests made by using the RBI grade 81 ash in the paper are, at 8% content liquid limit and plastic limit is same, MDD decreases and OMC increases with increase in the content value of treated soil at 8% of RBI is 3.5 times of untreated soil. in CBR value they have observed that improvement is at 4% of RBI.
- H. Gagan V “Soil Stabilization on Black Cotton Soil Using RBI Grade 81” (April 2018, IRJET): studied the stabilization of the expansive soil by using the RBI grade 81. They have told that there is a significant improvement in the index properties of the black cotton soil. they have made the basic test such as liquid limit, plastic limit, maximum dry density, optimum moisture content, CBR etc. they have done these tests at 0%, 2%, 4% and 6%. they have given the suggestion that this percentage can be improved 8% to 12%. for the good soil stabilization. and it reduces the construction time 40%..
- I. Madhusudan Ramchandra “Effects of Rice Husk Ash and Flyash On Index Properties of Black Cotton Soil” (august 2018, IRJET): they have discussed about the index properties of the expensive soil when it is mixed with the rice husk ash and fly ash. stabilization of black cotton soil using RBI grade 81 and fly ash they have done the CBR test at 5%, 10%, 15%, 20% and 25% and the result increases 24.17%, 37.09%, 45.69%, 39.40% and 26.15%. the maximum CBR is at 15% of both ashes. similarly, there is improvement in the strength, MDD at 15% of the both ashes.
- J. Kavyashree L “An Effect of RBI Grade 81 On Black Cotton Soil Stabilization” (April 2019, OMC): in this paper, effect of RBI grade 81 on black cotton soil stabilization study is carried out. after testing results were observed that, MDD of the soil increases with increase in the content of the RBI grade 81 and OMC will decrease with increase in the RBI content. in this paper they have concluded that in 6% of the RBI content is beneficial for the treatment of the black cotton soil. if the RBI content is more than 6% then there is decrease in the MDD and also there is increase in the OMC. by adding the RBI grade 81 liquid limit will reduce and plastic limit increases which results the increase in the plasticity index. by addition of the RBI grade 81 there is also increase in the CBR value and the ucs. so that the RBI grade 81 is unique.

### III. OBJECTIVES

The objectives of our project is to study the feasibility of RBI grade 81 and Fly ash used as effective and suitable stabilizer for stabilization of expansive soil. The main objectives of this experimental project include the:

- A. To analyse the characterization of Black cotton soil and suitability of use of Black cotton soil as subgrade material after stabilization.
- B. To examine the compaction, strength and volume change properties of Black cotton soil mixed with stabilizers.
- C. To study the influence of RBI grade 81 and fly ash as stabilizer on Durability of soil.

#### IV. METHODOLOGY

Various tests such as compaction test, unconfined compressive strength test, free swell index test and consolidation test are conducted to study the effect of RBI Grade 81 and Fly ash on Black cotton soil. Different percentage of Fly ash and RBI Grade 81 are added separately to the Black cotton soil to find out the optimum content of Fly ash and RBI Grade 81 needs to be added for the effective stabilization of Black cotton soil and later both Fly ash and RBI Grade 81 are added simultaneously keeping RBI Grade 81 as constant and varying the percentage of Fly ash as 5%, 10%, 15%, 20%, 25%, 30%.

These are the experiments conducted on Black cotton soil with or without additives:

- 1) Specific gravity
- 2) Atterberg's limits
  - a) Liquid limit
  - b) Plastic limit
  - c) Shrinkage limit
- 3) Free swell index test
- 4) Compaction test
- 5) Unconfined compressive strength test
- 6) Hydrometer analysis
- 7) Durability Test

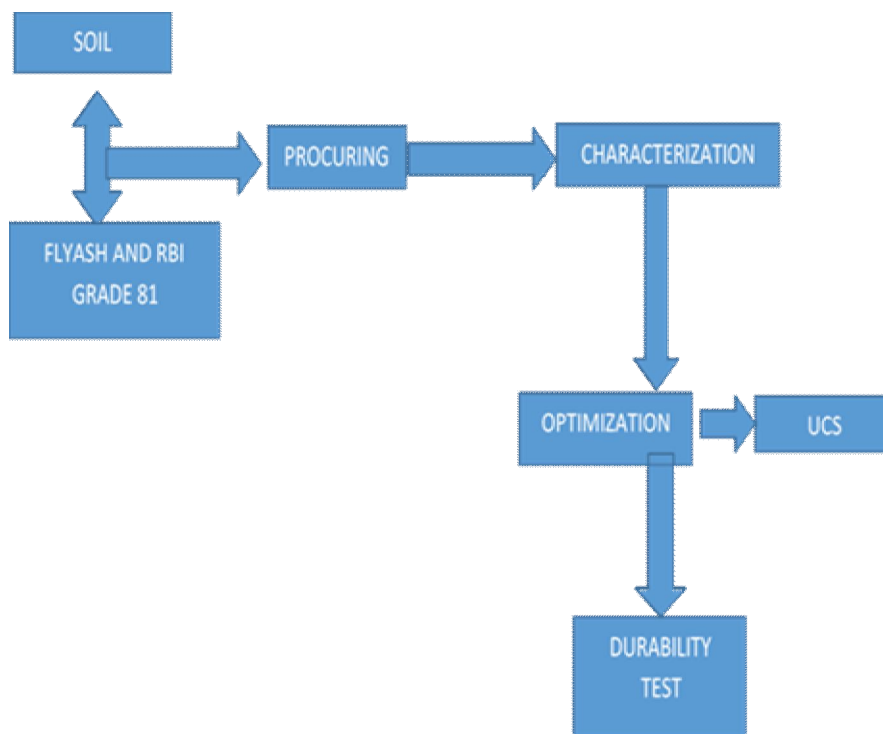


Fig. 1 Flow of Work

#### V. RESULTS

This chapter explains about the tests conducted on the Black Cotton Soil added with RBI grade 81 and fly ash as per to specified IS codes for each test. These tests are carried out in laboratory on the untreated black cotton soil and results obtained are tabulated in table 4.1. The characteristics of black cotton soil is added with RBI Grade 81 and fly ash are studied when strength of black cotton soil is increased when treating with Fly ash and RBI Grade 81. Black cotton soil is stabilized with Fly ash volume change characteristics improved are considerably.

Table I Basic Test Results on Black Cotton Soil

Sl No	Tests	IS Code	Results
1.	Specific Gravity	IS:2720 (Part 4) - 1980	2.42
2.	Liquid Limit	IS:2720 (Part 5) - 1985	80.09%
3.	Plastic Limit	IS:2720 (Part 5) - 1985	32%
4.	Shrinkage Limit	IS:2720 (Part 6) - 1982	9.86%
5.	Free Swell Index	IS:2720 (Part 40) - 1977	103%
6.	Maximum Dry Density	IS:2720 (Part 7) - 1980	1.46 g/cc
7.	Optimum Moisture Content	IS:2720 (Part 7) - 1980	31%
8.	Unconfined Compressive Strength	IS:2720 (Part 10) - 1993	122 /m2

A. Black Cotton soil Characteristics When Stabilized with Flyash or RBI Grade 81

Many tests are conducted in laboratory like compaction test, UCS and FSI test to carry out that optimum percentage value of Fly ash and RBI Grade 81 by stabilized with black cotton soil with different percentages of RBI Grade 81 and Fly ash.

1) *Compaction Test with Flyash:* The values of OMC and MDD of black cotton soil is stabilized with different combinations of fly ash content as shown in table 4.5. when MDD is increased and OMC value are decreased due to addition of fly ash content as treated up to 25% and beyond 25% of fly ash when OMC increased and MDD decreased. In that OMC values were decreased from 31% to 25.6% in addition of fly ash up to 25% for black cotton soil and MDD values were increased from 1.46g/cc to 1.48 g/cc and beyond 25% fly ash content is mixed with soil the OMC increased from 25.1% to 25.6% and MDD value of are decreased from 1.48g/cc to 1.42g/cc.

Table II Compaction Test Results for Varying Percentage of Flyash

Particulars	OMC (%)	MDD (g/cc)
BC soil + 0% fly ash	31	1.46
BC soil + 5% fly ash	27.6	1.462
BC soil + 10% fly ash	27.1	1.465
BC soil + 15% fly ash	26.8	1.469
BC soil + 20% fly ash	25.9	1.472
BC soil + 25% fly ash	25.6	1.48
BC soil + 30% fly ash	28	1.42

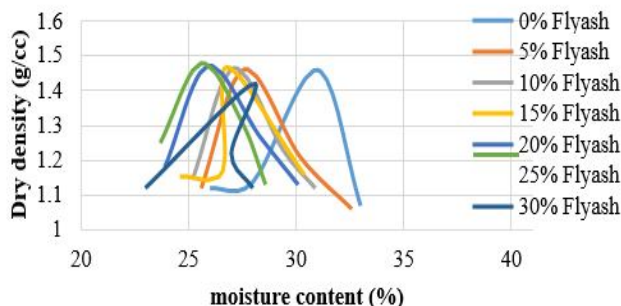


Fig. 2 Variation of MDD and OMC with Flyash

2) *Compaction Test with RBI Grade 81*: Compaction test are conducted according to as per IS code: 10074 (1982). Results are obtained and thus results of black cotton soil is stabilized and treated with different percentages are different combinations of RBI Grade 81 these values are listed in table 4.2. The OMC and MDD values for different percentages of RBI is stabilized with block cotton soil and representing in the graph as shown in figure 4.1. OMC and MDD results are obtained for untreated black cotton soil were 31 % and 1.46g/cc respectively.

Table III Compaction Test Results for Varying Percentage of RBI Grade 81

Particulars	OMC (%)	MDD (g/cc)
BC Soil + 0% RBI	37.43	1.46
BC Soil + 2% RBI	34.30	1.465
BC Soil + 4% RBI	31.10	1.47
BC Soil + 6% RBI	29.9	1.5
BC Soil + 8% RBI	32.4	1.41

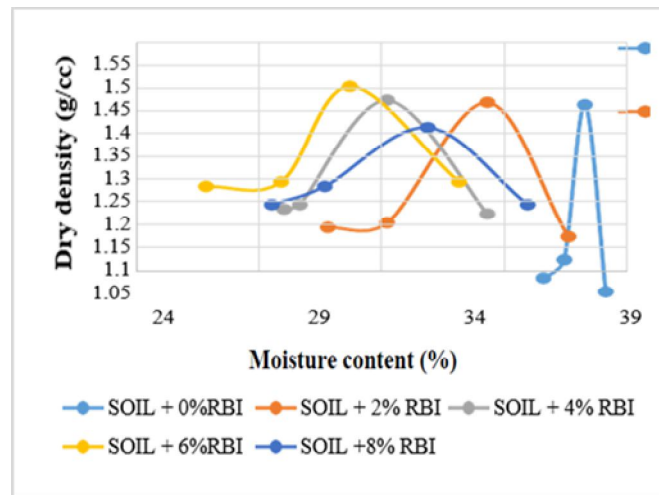


Fig. 3 Variation of MDD and OMC with Flyash

3) *Unconfined Compressive Strength Test with Flyash*: UCS test are conducted as per according is specification as per IS Code: 2720 (Part 10)-1993. The variation in UCS value of Black cotton soil is treated with different percentage of Fly ash as shown in table 4.6. The graph is shows that result between strain and compressive strength for various combination of Fly ash content is mixed with black cotton soil as shown in figure 4.5. And also indicated in figure 4.5 and well as indicated in table 4.6 unconfined compressive strength is tends to increase the strength when I addition of fly ash content up to 25% and after unconfined compressive strength decreased from 52.04kN/m<sup>2</sup> to 34.1kN/m<sup>2</sup>.

Table IV UCS Test Results for Varying Percentage of Flyash

Particulars	Unconfined Compressive Strength (kN/m <sup>2</sup> )
BC soil + 0% fly ash	122
BC soil + 5% fly ash	145
BC soil + 10% fly ash	169
BC soil + 15% fly ash	200
BC soil + 20% fly ash	230
BC soil + 25% fly ash	268
BC soil + 30% fly ash	210

The results are entered and shows that untreated Black cotton soil Unconfined compressive strength results was 122kN/m<sup>2</sup>. On addition of 5%, 10%, 15%, 20%, 25%, 30% Fly ash content corresponding to UCS value is found to be 145kN/m<sup>2</sup>, 169kN/m<sup>2</sup>, 200kN/m<sup>2</sup>, 230kN/m<sup>2</sup>, 268kN/m<sup>2</sup>, 210kN/m<sup>2</sup>, and 160kN/m<sup>2</sup>. UCS values of Black cotton soil increased from 122kN/m<sup>2</sup> to 268kN/m<sup>2</sup> up to 25% Fly ash content with addition and there after UCS value is slightly decreased on addition of Fly ash to Black cotton soil.

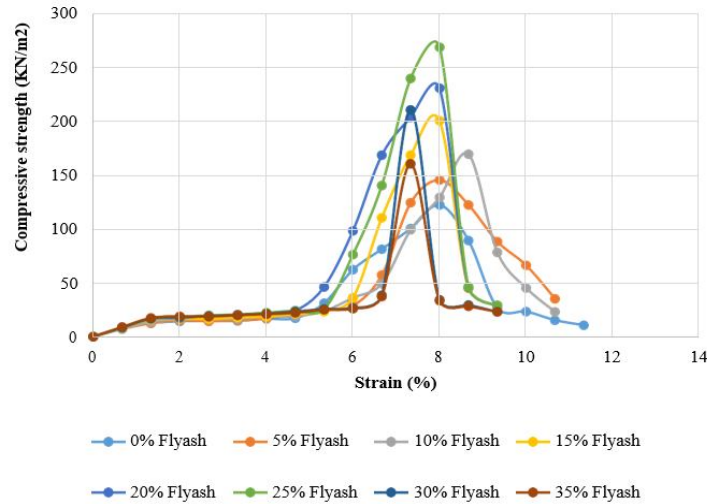


Fig. 4 Variation of MDD and OMC with Flyash

4) *Unconfined Compressive Strength Test with RBI Grade 81*: The Unconfined compressive strength test is conducted according to as per IS code: 2720 (Part 10)-1993. When variation in UCS value of black cotton soil is stabilized with different combination of RBI Grade 81 as shown in Table 4.3. The graph is represented between strain and compressive strength for various percentage of RBI Grade 81 is stabilized with Black cotton soil as shown in figure 4.2. So the values are indicated in figure and also indicated in table according to standard code the unconfined compressive strength results is tends to increase with addition of RBI Grade 81 stabilizer.

Table V UCS Test Results for Varying Percentage of RBI Grade 81

Particulars	Unconfined Compressive Strength (kN/m <sup>2</sup> )
BC Soil + 0% RBI	122
BC Soil + 2% RBI	153
BC Soil + 4% RBI	265
BC Soil + 6% RBI	295
BC Soil + 8% RBI	264

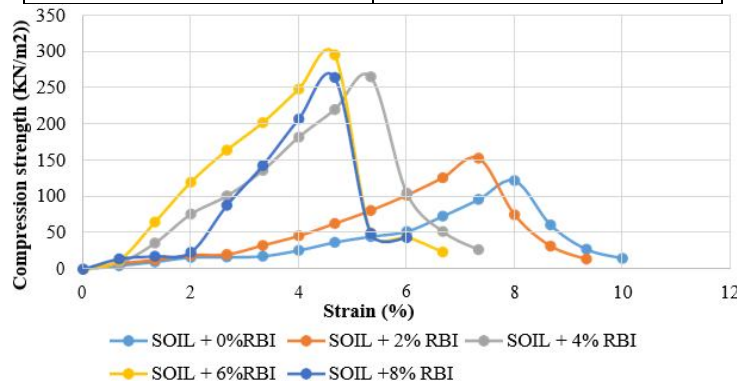


Fig. 5 Variation of UCS with Flyash

5) *Free Swell Index Test*: Free swell index test is performed according to as per IS Code: 2720 (part 4) – 1977. The variation FSI value was observed and tabulated in table 4.4. When decrease in swelling index value in addition of varying percentage of RBI Grade 81 are stabilized and changes is observed as shown in graph. Different combination of RBI Grade 81 (0%, 2%, 4%, 6%, and 8%) and FSI values obtained were 83.2%, 78.6%, 77.4%, 69.7%, 69.2% respectively. FSI value for untreated Black cotton soil obtained was 83.2 %. After increasing the percentage of RBI, FSI values is decreased from 83.2% to 69.2% to when compared to untreated Black cotton soil result. Hence Decrease in free swell index is less beyond 6% RBI. Hence 6% RBI content is considered as optimum value for further experiments.

Table VI FSI Test Results for Varying Percentage of RBI Grade 81

Particulars	Free Swell Index (%)
BC soil + 0% RBI	83.2
BC soil + 2% RBI	78.6
BC soil + 4% RBI	77.4
BC soil + 6% RBI	69.7
BC soil + 8% RBI	69.2

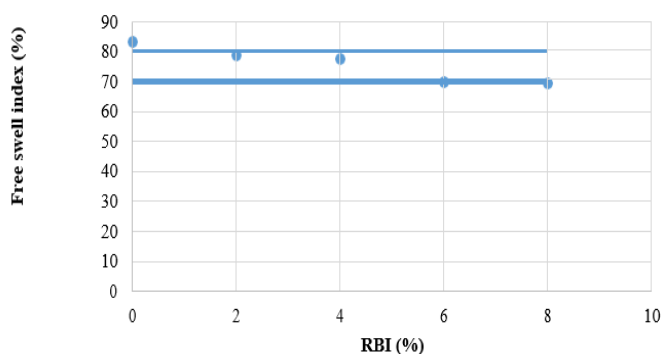


Fig. 6 Variation of FSI with RBI Grade 81.

**B. Black Cotton soil Characteristics When Stabilized with Flyash and RBI Grade 81.**

The Black cotton soil is treated with different percentage of stabilizer hence result is obtained the Optimum percentage of RBI and Fly ash are determined with many tests were conducted in laboratories the like that compaction test, unconfined compressive strength, FSI and consolidation test. Using optimum percentage value of RBI Grade 81 and varying percentage of Fly ash is mixed with block cotton soil till optimum value of Fly ash. Result was obtained by keeping the RBI percentage as constant and Fly ash percentage as variable and conduct the same experiments.

1) *Compaction Test with Flyash and RBI Grade 81*: Compaction test are conducted as per IS code: 10074 (1982). Compaction test results of Black cotton soil is treated with varying percentages of Fly ash content and optimum percentage (6%) of RBI Grade 81 are listed in table 4.7. The OMC and MDD values for varying percentages of Fly ash and optimum value of RBI Grade 81 stabilized with Black cotton soil are plotted as graph as shown in figure 4.6. OMC and MDD value are obtained for untreated black cotton soil were 31 % and 1.46g/cc respectively. After find out the optimum percentage of RBI grade 81 and Fly ash then Fly ash is kept constant and RBI percentage are changed. The changes of OMC and MDD value of black cotton soil with varying percentages of fly ash and optimum percentage (6%) of RBI grade 81 as shown in table 4.7. When MDD increased and OMC decreased. And treated with Fly ash of varying percentages and optimum percentage (6%) of RBI Grade 81. OMC values were decreased from 31 % to 28.5% on addition of different percentages of fly ash and optimum percentage of RBI Grade 81 for untreated block cotton soil and MDD values were increased from 1.460 g/cc to 1.53 g/cc. Optimum moisture content is decreased in that case CSH bond is formed due to addition of Fly ash less moisture content is absorbed after hydration reaction as it is stronger bond. Results are tabulated as shown in table 7. OMC and MDD values for varying percentage of Fly ash content (0%, 5%, 10%, 15%, 20%, and 25%) and constant value of RBI percentage (6%) obtained were 31%, 30.05%, 29.4%, 28.8%, 28.6%, and 28.5% respectively.

Table VII Compaction Test Results for Varying Percentage of RBI Grade 81 and Flyash

Particulars	OMC (%)	MDD (g/cc)
BC soil	31	1.46
BC soil + 6% RBI + 0% fly ash	30.05	1.469
BC soil + 6% RBI + 5% fly ash	29.4	1.478
BC soil + 6% RBI + 10% fly ash	28.8	1.49
BC soil + 6% RBI + 15% fly ash	28.6	1.51
BC soil + 6% RBI + 20% fly ash	28.55	1.515
BC soil + 6% RBI + 25% fly ash	28.5	1.53

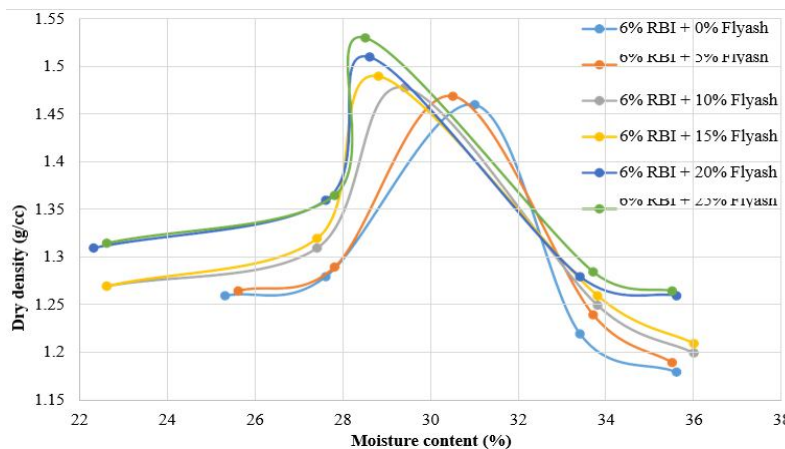


Fig. 7 Variation of Compaction with RBI Grade 81 and Flyash

2) *Unconfined Compressive Strength Test with Flyash and RBI Grade 81*: UCS test is conducted as per IS code: 2720 (Part 10)-1993. The variation in UCS value of Black cotton soil with varying percentage of Fly ash and optimum percentage value of (6%) of RBI Grade 81 as shown in Table 4.8. The graph is representation between strain and compressive strength for different percentage of Fly ash and optimum percentage of RBI mixed with the black cotton soil as shown in figure 4.7. As indicated in figure 4.7 and well as indicated in table 4.8 unconfined compressive strength is tends to increase with addition of different types percentages of Fly ash and optimum percentage of RBI. Unconfined compressive strength of soil increased from 38.234kN/m<sup>2</sup> to 65.633kN/m<sup>2</sup> on stabilizing with optimum value of RBI and varying percentage Fly ash content. The results are entered and shows untreated Black cotton soil UCS was 38.234kN/m<sup>2</sup>. On addition of 5%, 10%, 15%, 20%, and 25% Fly ash stabilizer and along with 6%RBI with respect UCS value were found to be 51.872kN/m<sup>2</sup>, 52.006kN/m<sup>2</sup>, 55.415kN/m<sup>2</sup>, 62.997kN/m<sup>2</sup>, 65.069kN/m<sup>2</sup>, and 65.633kN/m<sup>2</sup>. UCS values of Black cotton soil is increased to 65.633kN/m<sup>2</sup> on 25% Fly ash addition and 6% RBI addition.

Table VIII UCS Test Results for Varying Percentage of RBI Grade 81 and Flyash

Particulars	Unconfined Compressive Strength (KN/m <sup>2</sup> )
BC soil	122
BC soil + 6% RBI + 0% fly ash	296
BC soil + 6% RBI + 5% fly ash	318
BC soil + 6% RBI + 10% fly ash	347
BC soil + 6% RBI + 15% fly ash	359
BC soil + 6% RBI + 20% fly ash	361
BC soil + 6% RBI + 25% fly ash	397

The increase in fly ash content and optimum percentage (6%) of RBI addition to black cotton soil UCS value increased from 38.234kN/m<sup>2</sup> to 65.633kN/m<sup>2</sup>. Hence 25% Fly ash and 6% RBI used as optimum values further experiments or soil stabilization and improve of compressive strength of black cotton soil.

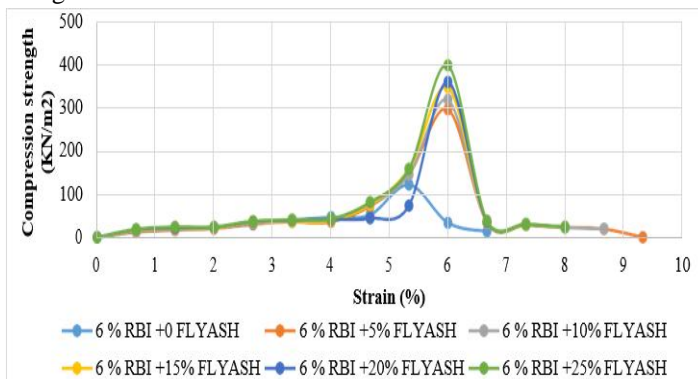


Fig. 8 Variation of UCS with RBI Grade 81 and Flyash

3) *Free Swell Index Test with Flyash and RBI Grade 81*: Free swell index is performed as per IS code: 2720 (part 40) – 1977. The variation in FSI value was observed and tabulated in table 4.9. When Decrease in swelling index value on addition of optimum percentage (6%) RBI and different percentage of Fly ash is observed as shown in figure 4.8. On addition of optimum value of (6%) RBI and varying percentage of Fly ash (0%, 5%, 10%, 15%, 20%, 25%, 30%) FSI values obtained were 69.2%, 65.45%, 54.65%, 53.12%, 47.65%, 43.25%, and 38.49% respectively. Free swell index value is treated like with untreated black cotton soil obtained results was 103%. After increasing Fly ash content with adding the optimum percentage of RBI value FSI value is decreased from 103% to 43.25% when compared to untreated black cotton soil. Hence strength are compared with that other experiments and find out optimum value for further works.

Table IX UCS Test Results for Varying Percentage of RBI Grade 81 and Flyash

Particulars	Free Swell Index (%)
BC soil + 6% RBI + 0% fly ash	69.2
BC soil + 6% RBI + 5% fly ash	65.45
BC soil + 6% RBI + 10% fly ash	54.65
BC soil + 6% RBI + 15% fly ash	53.12
BC soil + 6% RBI + 20% fly ash	47.65
BC soil + 6% RBI + 25% fly ash	43.25
BC soil + 6% RBI + 30% fly ash	38.49

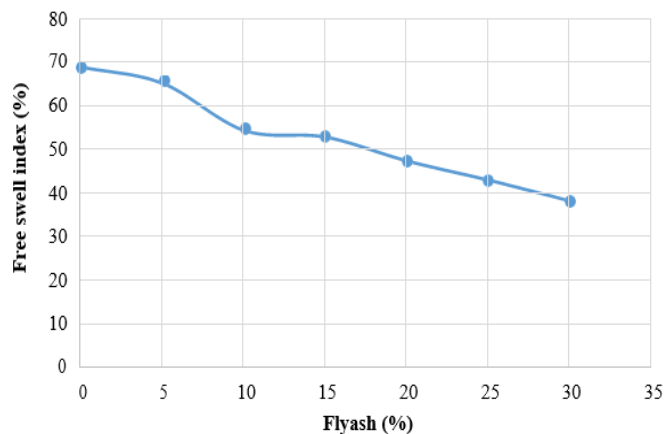


Fig. 9 Variation of FSI with RBI Grade 81 and Flyash

## VI. CONCLUSIONS AND FURTHER SCOPE

Based on experiments and investigations, the following remarks were made

- 1) The Black cotton soil specimen is of high plasticity clay which is confirmed by drawing Plasticity chart in accordance to IS soil classification system (IS:1498 – 1970).
- 2) Black cotton soil with up to 25% of fly ash content the MDD value is increased from 1.46 g/cc to 1.48 g/cc and OMC is decreased from 31% to 25.6%.
- 3) The maximum dry density of black cotton soil decreases when flyash content is increased above 25% from 1.48 g/cc to 1.42 g/cc and also OMC increases from 25.6% to 28%. Therefore, for effective stabilization of black cotton soil 25% of flyash is considered as optimum content.
- 4) MDD value is decreased when RBI Grade 81 is added beyond 6% from 1.5g/cc to 1.41 g/cc and OMC is increased from 29.9% to 32.4%. Hence 6% of RBI Grade 81 is considered to as the optimum content to be added to the Black cotton soil for stabilization.
- 5) Addition of optimum content of both RBI Grade 81 (6%) and Fly ash (25%) resulting to increase MDD from 1.46 g/cc to 1.53 g/cc and decreased in OMC from 30.05% to 28.5%.
- 6) UCS is increased from 122kN/m<sup>2</sup> to 268kN/m<sup>2</sup> up to optimum content of Fly ash (25%) treated with Black cotton soil and beyond 25% of Fly ash it decreased from 268kN/m<sup>2</sup> to 210kN/m<sup>2</sup> . Therefore 25% Fly ash considered to be optimum.
- 7) Up to 6% RBI Grade 81 UCS is increased from 122 kN/m<sup>2</sup> to 295 kN/m<sup>2</sup> mixed with Black cotton soil and UCS is decreased from 295 kN/m<sup>2</sup> to 264 kN/ m<sup>2</sup> with addition of RBI Grade 81 beyond 6%.
- 8) UCS increased from 122kN/m<sup>2</sup> to 397 kN/m<sup>2</sup> when 6% of RBI Grade 81 and 25% of fly ash is mixed with Black cotton soil.
- 9) FSI of Black cotton soil is decreased from 83.2% to 69.7% with addition RBI Grade 81 up to 6% and after this there is no significant decrease in FSI is observed from 69.7% to 69.2%. Therefore 6% of RBI is taken as optimum and FSI of black cotton soil is decreased from 69.2% to 43.25% when treated with optimum content of RBI Grade 81 and fly ash.

Based on the research the following are scope for future works.

- a) Stabilizers like RBI Grade 81 and Fly ash are used to stabilize almost all types of soil.
- b) Black cotton soil that is stabilized with Fly ash and RBI Grade 81 are used in the road construction which improves the strength and volume change property of soil.
- c) Compared to Cement and Lime, Fly ash is economical for the stabilization.

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