After reviewing different Authors papers first, we have to collect the materials that are required for conducting the project. After collecting the materials, we will determine the standard soil properties to determine its Class. Our next step is to find the optimum combination for soil stabilization with Rice Husk Ash and $CaCl_2$.

After finding the optimum combination the further step is to determine the soil reinforcement (Plastic Fiber) combination.

Materials used During the Testing

1. Subgrade Soil (Black Cotton Soil).
2. Rice Husk Ash (RHA).
3. Calcium Chloride ($CaCl_2$).
4. Plastic Fiber.

Fig-1 Black Cotton Soil

Fig-2 Rice Husk Ash

Fig-3 Calcium Chloride

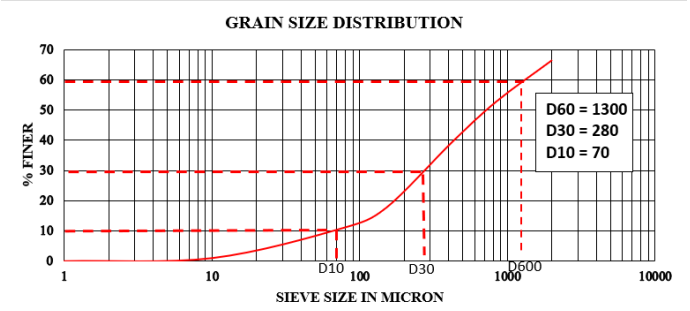
Fig-4 Plastic Fiber

Table-1 Experimental Programme.

Soil Combination	Tests Conducted
Soil alone	Grain size distribution
Soil + RHA	Specific gravity
Soil + $CaCl_2$	Atterberg limits
Soil + RHA + $CaCl_2$	Compaction test
Soil + RHA + $CaCl_2$ + Plastic Fiber	CBR test Free swell index

3. BLACK COTTON SOIL OBSERVATIONS

3.1 Grain Size Distribution



Graph-1: Grain size distribution graph

The value of coefficient of curvature, C_c obtained for Black Cotton Soil is 18.57 and that of coefficient of uniformity, C_u is obtained as 0.86. For the graded soil the standard value of C_c lies between 1 and 3 and for fine soil the C_u value should be greater than 6. Since both of these criteria are not met, the soil is classified as poorly graded.

3.2 Specific Gravity

Table-2: Specific gravity

SAMPLE	1	2	3

SPECIFIC GRAVITY	2.32	2.31	2.33

The specific gravity of Black Cotton Soil has been obtained as 2.32. The specific gravity of soil normally has a range of 2 - 2.8 and hence the Black Cotton Soil is within the specified range.

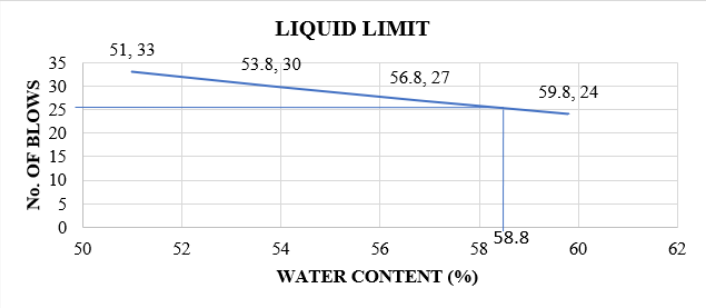
3.3 Atterberg's Limit

a. **Shrinkage limit**-From the experiment the shrinkage limit of soil has been obtained as 12.12% and shrinkage ratio is obtained as 1.89. This shows that the shrinkage limit of the soil is low.

b. **Liquid limit:**

Table-3: Liquid limit

WATER CONTENT	51	53.8	56.8	59.8
NO. OF BLOWS	33	30	27	24



Graph-2: Liquid Limit Graph

The liquid limit of the soil is obtained from the graph corresponding to 25 blows as 58.8%. Hence the liquid limit of the soils high.

c. **Plastic limit**

Table-4: Plastic Limit

SAMPLE	1	2	3
PLASTIC LIMIT	23.08	28.57	37.5

The average plastic limit of soil is obtained as 29.72%. Hence the soil is highly plastic.

d. **Liquidity index**

Liquidity index of the soil is obtained as -0.27. Since the liquidity index is less than zero the soil is in semi-solid state and is stiff.

e. **Consistency index**

The consistency index of the soil is obtained as 1.27. Since the liquidity index is greater than one the soil is in semi-solid state and is stiff.

f. **Shrinkage index**

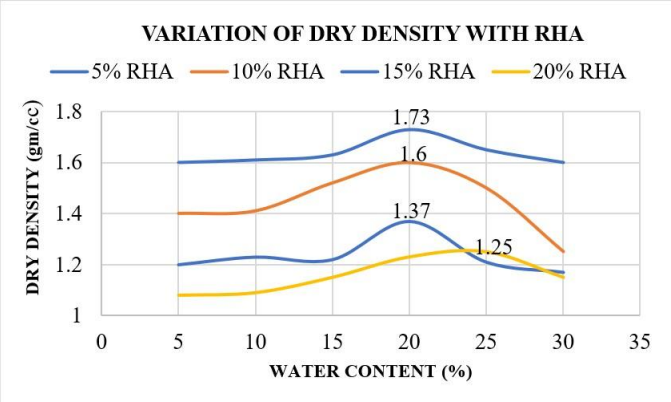
The shrinkage index of soil is obtained as 17.6%.

g. **Plasticity index**

The plasticity index of the soil is obtained as 29.08% and the A- line is obtained as 28.324%. As per the plasticity chart we obtained that the soil is above A-line and hence belongs to CH group. Thus, soil is highly clay or high plasticity.

4. OPTIMISATION FOR SOIL STABILISATION

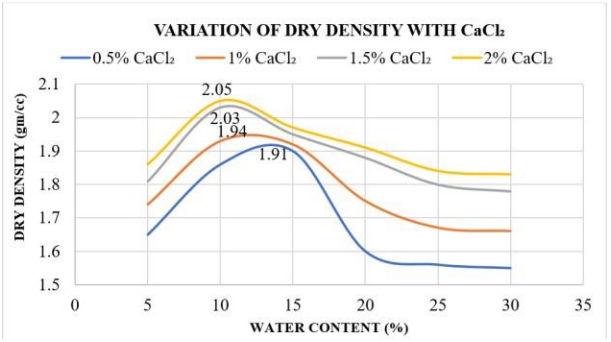
4.1 Effect of RHA (Rice Husk Ash) on Black Cotton Soil



Graph-3: Effect of RHA on Black Cotton Soil

Compaction of soil with RHA showed a decrease in dry density with increasing OMC

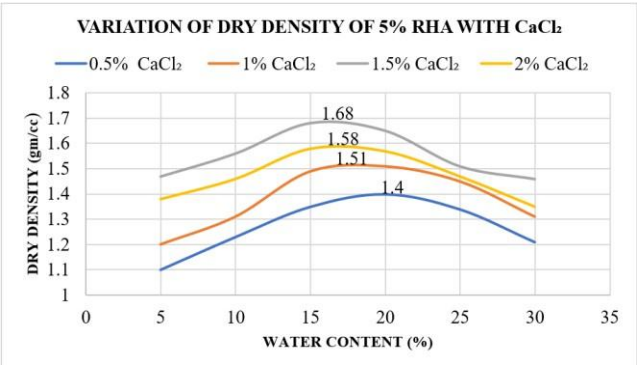
4.2 Effect of $CaCl_2$ (Calcium Chloride) on Black Cotton Soil



Graph-4: Effect of $CaCl_2$ on Black Cotton Soil

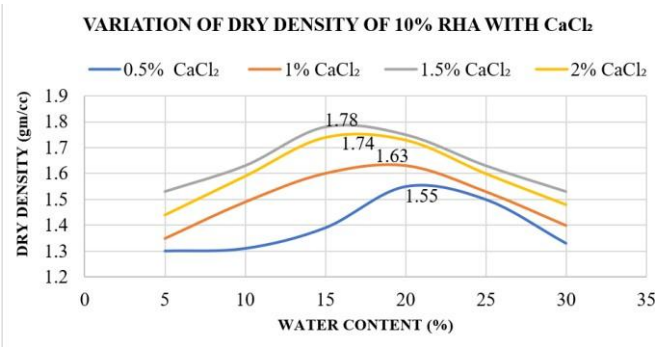
Compaction of soil with $CaCl_2$ showed an increase in dry density with decreasing OMC

4.3 Effect of $CaCl_2$ and 5% RHA on Black Cotton Soil



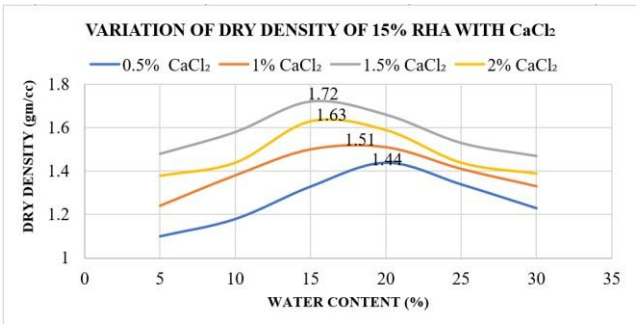
Graph-5: Effect of $CaCl_2$ and 5% RHA on Black Cotton Soil

4.4 Effect of $CaCl_2$ and 10% RHA on Black Cotton Soil



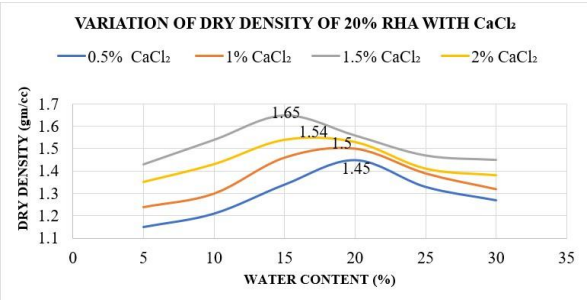
Graph-6: Effect of $CaCl_2$ and 10% RHA on Black Cotton Soil

4.5 Effect of $CaCl_2$ and 15%RHA on Black Cotton Soil



Graph-7: Effect of $CaCl_2$ and 15% RHA on Black Cotton Soil

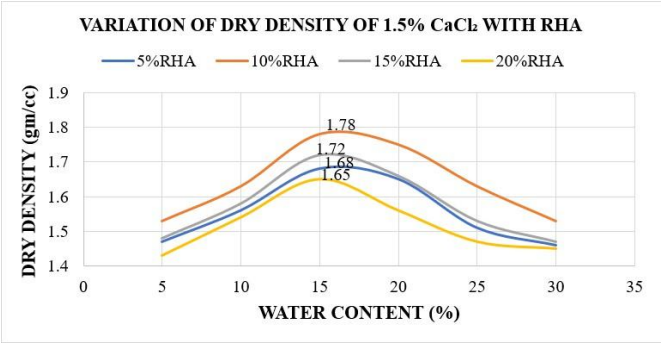
4.6 Effect of CaCl2 and 20%RHA on Black Cotton Soil



Graph-8: Effect of CaCl2 and 20%RHA on Black Cotton Soil

The optimum combination is taken as 20% RHA with 1.5% $CaCl_2$ which has maximum dry density with minimum water content.

4.7 Effect of RHA and 1.5%$CaCl_2$ on Black Cotton Soil

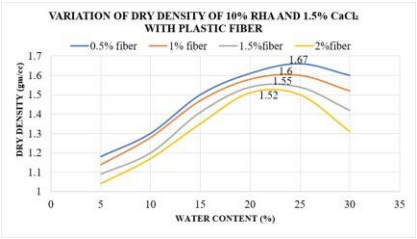


Graph-9: Effect of RHA and 1.5% CaCl2 on Black Cotton Soil

The optimum combination is taken as 10% RHA with 1.5% CaCl2 which has maximum dry density with minimum water content.

4.8 OPTIMISATION FOR SOIL REINFORCEMENT

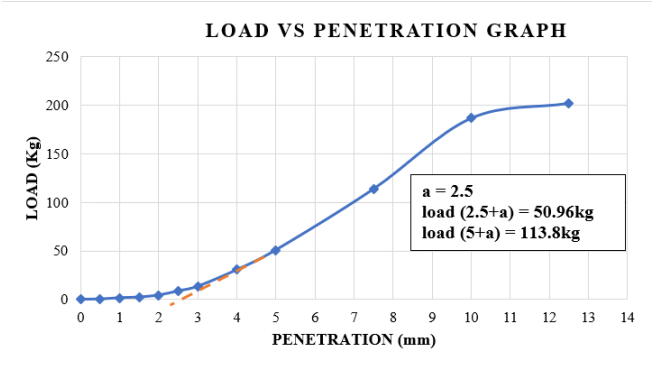
Effect of Plastic Fiber, 10%RHA and 1.5%$CaCl_2$ on Black Cotton Soil



Graph-10: Effect of Plastic Fiber, 10%RHA and 1.5%CaCl2 on Black Cotton Soil

5. ANALYSIS FOR SOIL STABILISED SOIL PROPERTY

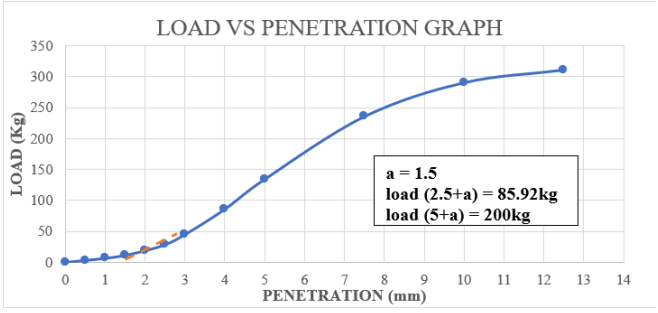
5.1 California Bearing Ratio test with10% RHA and 1.5% $CaCl_2$ stabilized soil



Graph-11: CBR of stabilized soil with10% RHA and 1.5% $CaCl_2$Stabilized soil

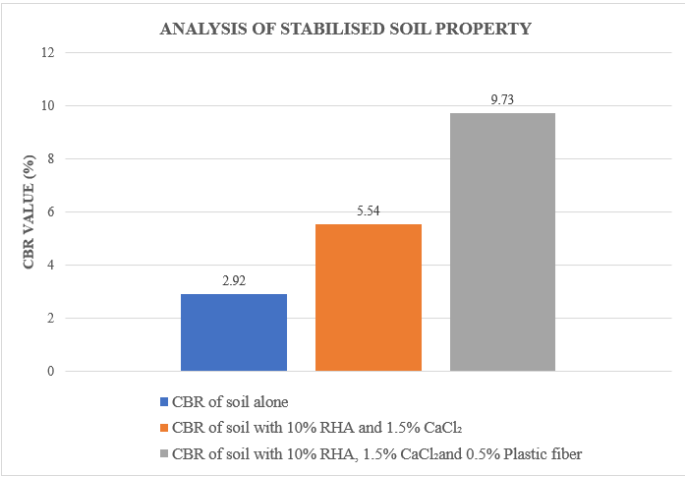
CBR value with10% RHA and 1.5% $CaCl_2$ stabilized soil is obtained as 5.54%.

5.2 California Bearing Ratio test with10% RHA, 1.5% $CaCl_2$and 0.5% Plastic Fiber stabilized soil



Graph-12: CBR test with10% RHA, 1.5% $CaCl_2$and0.5%Plastic fiber stabilized soil

CBR value with10% RHA, 1.5% CaCl2 and 0.5% Plastic Fiber stabilized soil is obtained as 9.73%.



Graph-13: Analysis of stabilized soil property

6. CONCLUSION

- RHA and $CaCl_2$ can't be used alone for stabilizing process as they lack cementing agent for increased strength and are difficult to pulverized soil at low water content respectively. Thus, optimization of above 2 combinations can be an effective method for soil stabilization and it is found at 10% RHA and 1.5% $CaCl_2$.
- Reinforcing the soil with Plastic Fibber can improve the strength characteristics of the soil and the optimum performing subgrade is obtained with the application of 10% RHA, 1.5% $CaCl_2$ and 0.5% Plastic Fibber.
- The CBR value of Black Cotton Soil increased after addition of 10%RHA + 1.5% $CaCl_2$ (5.54%) and 10%RHA + 1.5% $CaCl_2$ + 0.5% Plastic Fiber (9.73%) as compared to untreated soil (2.92%). Good CBR value increases the stability of soil.

7. REFERENCES

[1] Soundara B and Senthil Kumar K. P, *"Effect of Fiber on Properties of Clay"*, International Journal of Engineering and Applied Sciences (IJEAS), ISSN: 2394-3661, Volume-2, Issue-5, May 2015.

[2] Vidya Tilak B., Rakesh Kumar Dutta and Bijayananda Mohanty, *"Effect of Plastic Fibres on The Compaction and Unconfined*

Compressive Strength of Bentonite-Lime-Gypsum Mixture", Slovak Journal of Civil Engineering, Vol. 23, No. 2, pp. 1 – 8, 2015.

[3] Khushbu S. Gandhi, *"Experimental Study of Surat Region Expansive Soil Modified Using Bagasse Ash and Wood Ash",* International Journal in IT and Engineering [IJITE], Vol.2, Issue-12, pp. 62-70, (December 2014).

[4] Amit Tiwari and H. K. Mahiyar *,"Experimental Study on Stabilization of Black Cotton Soil by Fly Ash, Coconut Plastic Fibre & Crushed Glass",* International Journal of Emerging Technology and Advanced Engineering, Volume 4, Issue 11, pp. 330-333,November 2014.

[5] Anil Kumar Singhai and Sudhanshu Shekhar Singh, "Laboratory Study on Soil Stabilization Using Fly Ash and Rice Husk Ash", International Journal of Research in Engineering and Technology (IJRET), Volume: 0, Issue: 11, pp. 348 -351 Nov-2014.

[6] Saibal Chakraborty, S P Mukherjee and B C Chattopadhyay, *"Improvement of Sub Grade Strength by Admixtures",* International Journal of Engineering Research and Science & Technology, Vol. 3, No. 3, pp. 185-194, August 2014.