International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 07 | July-2018 www.irjet.net p-ISSN: 2395-0072

EVALUATION OF PROPERTIES OF THE EXPANSIVE SOIL USING STEEL SLAG AND POLYPROPYLENE FIBERS

Jahnavi P[1], Melitia D Mello[2]

[1]*M.tech Student, Dept of Civil Engineering Shree Devi Institute of Technology, Kenjar, Karnataka, India*
[2]*Assistant Professor, Dept of Civil Engineering Shree Devi Institute of Technology, Kenjar Karnataka, India*

Abstract— *As the population increases there will be reduction in the available land, development of buildings are usually implement on weak soil. Weak soil has poor shear strength, high swelling and high shrinkage. So such kind of soil requires ground improvement techniques to enhance the reliability of construction. Among weak soils major portion will be black cotton soil. Expansive soil or black cotton soil severely damaged because of shrinkage and Swelling behavior.. Soil stabilization is the major technique to enhance the geotechnical properties of soil and it is one of the major practicing techniques in construction engineering. This study aims to check the improvements in black cotton soil by using steel slag and polypropylene fibers. Steel slag were added in percentages of 3%, 6%, 9%, 12%, 15% and Polypropylene fibers were added in the percentages of 1%, 2%, 3%. Steel fibers are industrial waste which reduce the clay content and increases the strength whereas Polypropylene fibers having increase in tensile strength. These stabilizers were added to enhance the strength properties and make them more suitable to use and noted that there will be Change in various soil properties such as plastic limit, liquid limit, Shrinkage limit, Maximum dry density, Optimum Moisture Content, Un Confined Compression Strength, California Bearing Ratio, Permeability of soil, Triaxial Shear strength of soil were studied.*

Keywords: Black Cotton Soil, Steel slag, Polypropylene fibers, MDD, UCS, CBR and Triaxial test

1. INTRODUCTION

In India it is found that about 20% of the soil is black cotton soil. Black cotton soil is a clayey soil which is more plastic. This black cotton soil generally undergoes the shrinkage and also swelling. Swelling is due absorption of more amount of water and Shrinkage will occurs when the water dries.

An Industries discard the million tons of wastes which is produced from their productions. Disposal of this million tons of waste is quite problem because of environmental concern

Some of the wastes that produced from the industries are eco friendly. As they are eco friendly they can be reused. As the wastes are eco friendly in nature they can be used to stabilise the soil. Soil stabilisation can be defined as effective and reliable technical that alter the engineering properties. Stabilisation of soil helps to deal with problem of disposal and improves the geotechnical properties of black cotton soil.

Different Methods of soil Stabilisation:

1. Physical method
(a) Vibration
(b)Thermo electrical
(c) Freezing and thawing

2. Chemical Method
(a) Conventional method-Cement, Lime
(b) Enzymes
(c) Polymeric Resins

3. Mechanical method
(a) Using fibre material
(b) Compaction

1.2. MATERIALS USED

The materials to be used in the present study will be collected from various places and the basic tests were carried out on the procured materials to study the material properties in order to make suit the material for the project.

1.2.1 Black Cotton Soil

Black Cotton Soil is soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dry out. In India this Expansive soil is called “Black Cotton Soil”.

Fig- 1: Black cotton soil

1.2.2 Steel Slag

During manufacturing of steel the steel slag is produced as waste product. There are many factors like fineness, carbon content, and iron content, gradation etc., mainly control the strength of soil treated with steel slag.

Fig-2: Steel Slag

1.2.3 Polypropylene fibers

Polypropylene fibers are synthetic materials. In this study 12mm length fibers are used. These fibers are hydrophobic, non corrosive and it is highly resistant to alkalies, chemicals and chlorides.

Fig- 3: Polypropylene Fibers

2. TESTS CONDUCTED ON BLACK COTTON SOIL

Before commencement of any road work, collection of soil sample from that place has to be done and tests are carried out in order to know the suitability of the soil.

1. Specific Gravity
2. Grain Size Distribution
3. Atterberg's Limits
   (a) Plastic Limit
   (b) Liquid Limit
4. Shrinkage Limit
5. Standard Compaction test
6. Unconfined Compressive Strength
7. California Bearing Ratio Test
   (a) Soaked Condition
   (b)Un soaked Condition
8. Permeability test
   (a) Constant Head Method
   (b) Variable Head Method
9. Triaxial Test

3. RESULTS AND DISCUSSIONS

Table-1: Properties of black cotton soil

Sl.No.	Black cotton soil property	Value
1	Specific Gravity	2.5
2	Sieve Analysis IS Classification	Cc= 0.44 Cu = 4 CH
3	Liquid limit (%)	56
4	Plastic Limit (%)	27.85
5	Shrinkage Limit (%)	32
6	Maximum Dry density **(gm/cc)**	1.62
7	Optimum moisture content **(%)**	18
8	Unconfined compression test **(kN/m²)**	153
9	California bearing ratio (a) Soaked **(%)** (b) Unsoaked **(%)**	 3.29 2.47
10	Permeability test**(cm/sec)** (a) Variable head method (b) Constant head method	 0.0037 0.0012
11	Triaxial test (a) Cohesion (kN/cm²) (b) Angle of shear resistance ϕ (degrees)	 1.67 17.23

3.1. RESULTS OF THE VARIOUS TESTS ON BLACK COTTON SOIL WITH THE ADDITION OF STABILISERS

3.1.1 Plastic Limit

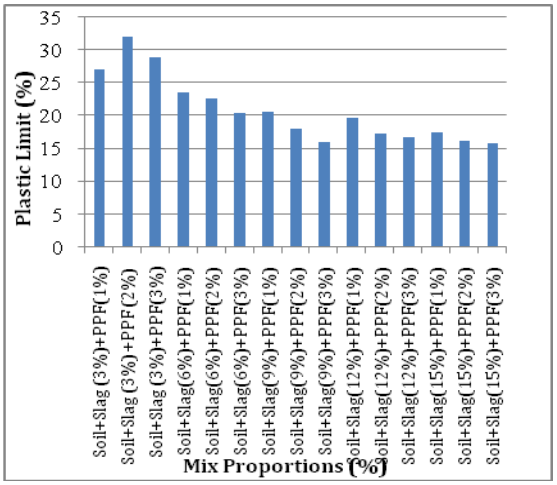

Chart-1: Variation of plastic limit with different proportion of steel slag and Polypropylene fibers

As shown in above figure plastic limit of soil sample is decreases with addition of different proportion of steel slag and polypropylene fibers which are may be due to the increase in steel slag and fiber content

3.1.2 Liquid Limit

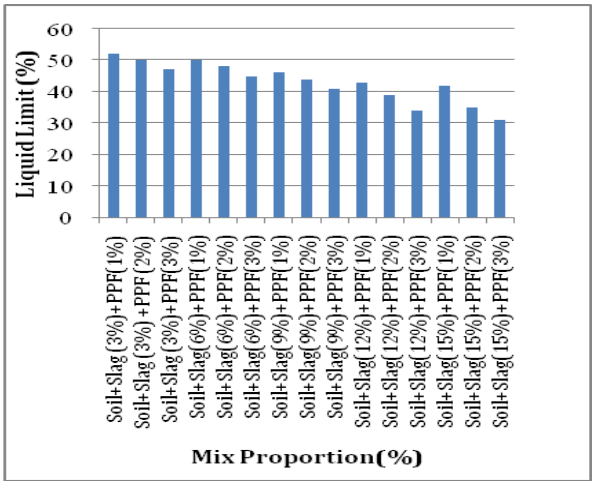

Chart-2: Variation of Liquid Limit with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure liquid limit goes on decreasing by the addition of steel slag and polypropylene fibers. The main reason is due increase of stilt and fiber content.

3.1.3 Maximum Dry Density

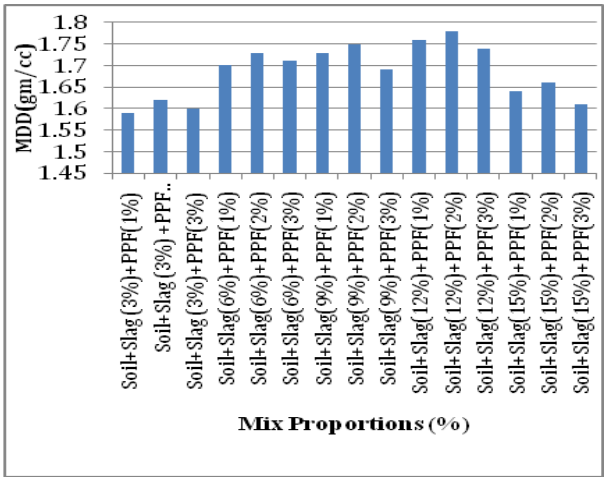

Chart-3: Variation of Maximum Dry Density with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure Steel slag and polypropylene fibers are added to the soil in various proportions to the soil. Percentage of Steel slag and PPF is mixed with soil specimen the highest value of MDD is 1.78 gm/cc at 12% of steel slag and 2% of PPF. Addition 15% of steel slag and 3% of PPF the MDD value is 1.61 gm/cc.

3.1.4 Optimum Moisture Content

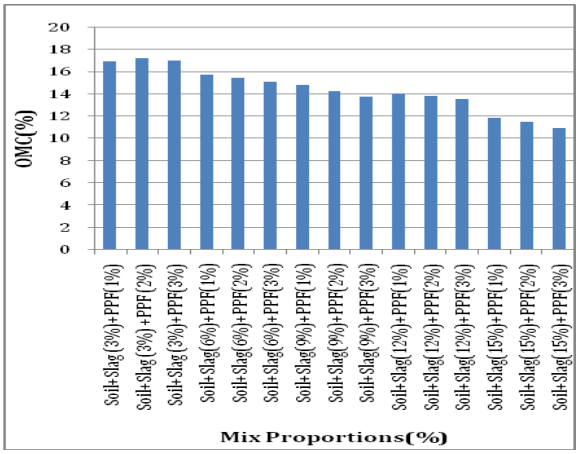

Chart-4: Variation of Optimum Moisture Content with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure Steel slag and polypropylene fibers are added to the soil in various proportions so that OMC values keeps on decreases this is mainly due to addition of steel slag reduces the voids formed in the soil and fibers absorb more amount of water at the mixing stage. With addition of 3% steel slag and 2% PPF the OMC is 17.2%. At 15% steel slag and 3% PPF the OMC is 10.9%. This shows decrease of optimum moisture content with addition of both steel slag and polypropylene fibers.

3.1.5 Unconfined Compression Strength

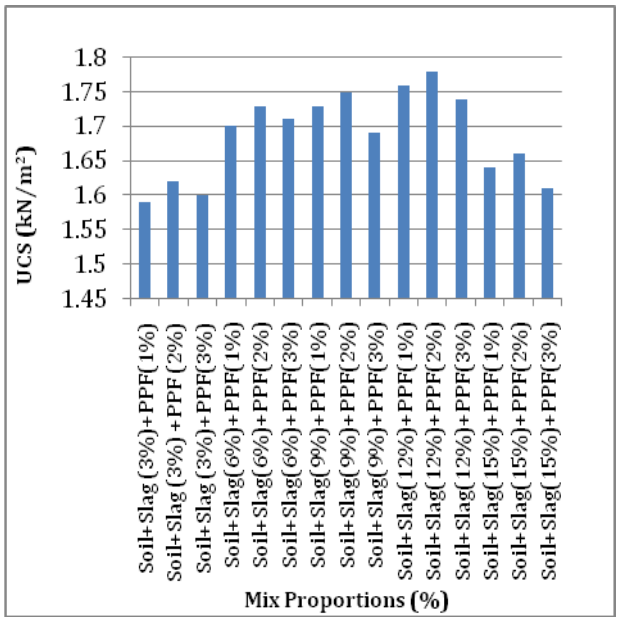

Chart-5: Variation of UCS with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure UCS increases with addition of steel slag and polypropylene fibers. The maximum value of UCS is 1.78 kN/m² at 12% of steel slag and 2% of fiber, beyond 12% of steel slag and beyond 2% of fiber UCS value decreases mainly due to increases in density and also decrease of water holding capacity of the soil.

3.1.6 California Bearing Ratio

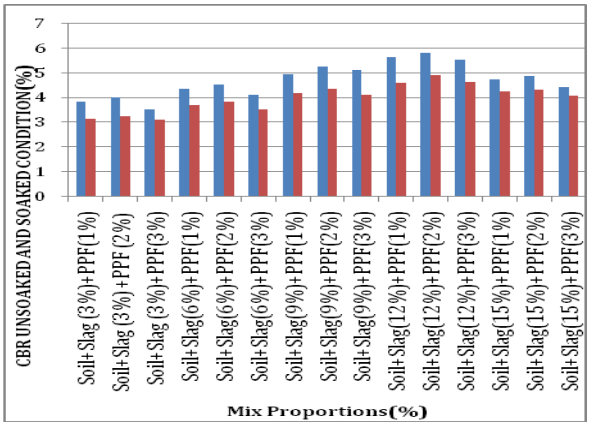

Chart-6: Variation of CBR with addition of different proportion of Steel Slag and Polypropylene Fiber.

As shown in above figure by addition of steel slag and polypropylene fibers to the soil shows increases in CBR value. CBR value of soil attains the maximum at 15% steel slag and 2% of PPF is 4.86% and 4.30% for unsoaked and soaked conditions.

3.1.7 Permeability Test

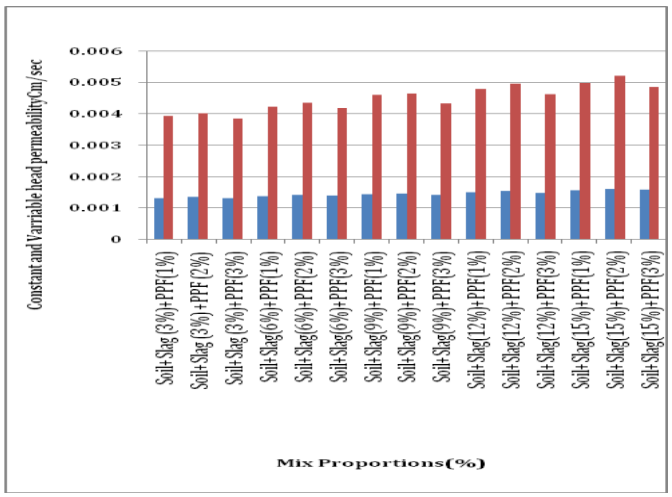

Chart-7: Variation of Permeability with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure permeability of the soil increases with addition of Steel slag and fiber content. Constant and Falling head permeability method is conducted .By both the method permeability of soil increases.

3.1.8 Triaxial Test

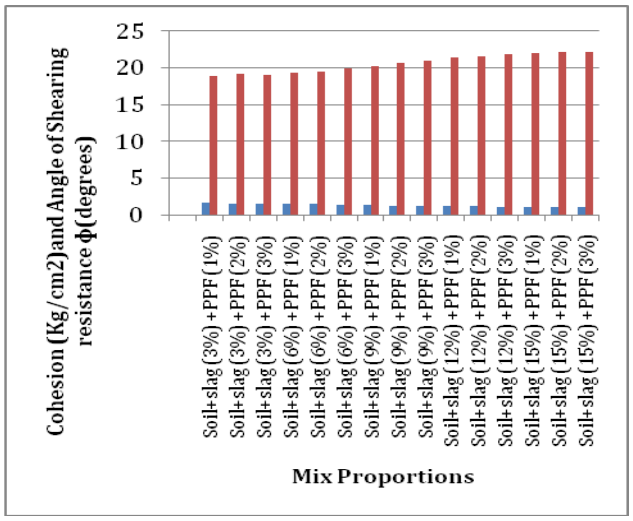

Chart-8: Variation of Cohesion and Angle of shearing resistance with addition of different proportion of Steel Slag and Polypropylene Fibers

As shown in above figure with increase of steel slag content and fiber content in the soil results in decrease in cohesion value. This is mainly due to increase of silt and fibers content and decrease of clay content, with increase of steel slag content and fiber content in the soil results in increases the angle of shearing resistance. This happens because of increase in slit and fiber content in the soil and reduction of clay content in the soil.

4. CONCLUSIONS

The study can be concluded as follows

- It is observed that liquidity and plasticity of the soil decreases with addition of steel slag and polypropylene fibers this happens because of non plastic nature of soil.
- There will be appreciable improvements in the optimum moisture content and maximum dry density when treated with steel slag and polypropylene fibers.
- The addition of stabilisers increases the unconfined compression strength value more than the ordinary methods.
- Steel slag and Polypropylene fibers improves the California Bearing ratio of the soil.
- Addition of steel slag makes the soil more permeable whereas addition of polypropylene fibers decreases the permeability of the soil.
- With addition of steel slag makes the soil less cohesive there will more shearing resistance and

with addition of fibers the soil will be more cohesive and less shearing resistance.

- Stabilisation of soil with Steel slag and polypropylene fibers improves the strength behaviour of sub base.
- It can reduce ground improvement costs by adopting this method of stabilisation.

REFERENCES

[1] A.S.Soganic 2015, "The effect of polypropylene fiber in the stabilisation of expansive soils", ISSRI, vol .9

[2] Chippada Srinivas (2017) "Experimental investigation of expansive soil stabilisation by using steel slag", International journal of mechanics and soilds.ISSN:0973-1881, volume 12, number 1

[3] Dharmendra Sahu (2016)"Effect on engineering properties of black cotton soil by alkali content", International journal for innovative research engineering science and technology ISNN: 0975-5462, Volume 4.number 02

[4] IS code for liquid limit IS: 2720(Part 5)-1985

[5] IS code for plastic limit IS: 2720(Part 5)-1985

[6] IS code for determination of water content and dry density relation using light compaction code 2720(Part 7)-1987

[7] IS code for Unconfined Compression strength IS 2720-Part 10

[8] IS code for CBR IS 2720-Part (16)-1987

[9] IS code for permeability IS 2720 Part (17)-1986

[10] IS code for triaxial test IS 2720-1973