SOIL STABILIZATION USING STEEL FIBER

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Abstract : Soil stabilization is required to increase the strength and reduce settlement of poor soil by means of control compaction, proportioning and adding suitable stabilizers. To stabilize poor soil there is always a need of material which is cost Economical and environmental friendly which can impart desired strength with effectiveness in constructions. There are several stabilizers like rice husk, wheat straw, coir, bagasse, sisal, jute, polypropylene, polyvinyl, nylon fibers. Steel fiber is also one such stabilizer which is available as a waste in steel industries. As the use of steel is increasing day by day it is easily available. It is not economical to reuse of steel waste by steel industries as it affect the cost and quality of the steel so it is not suitable to reuse it. The disposal of steel waste without causing any environmental and ecological hazard is also a challenge. So it is essential to use the steel fiber in the form it is available from steel industry. The use of steel fiber as a reinforcement to strengthen and reduce settlement of poor/weak soil is one such solution. This thesis proposes this solution and examines the effect of steel fiber on poor /weak soil by means of various tests like moisture content test, sieve analysis, liquid limit, plastic limit test, specific gravity test, standard proctor test, on different samples. The result obtained are promising and support the fact of achieving stability of soil. The soil sample used is poor/weak soil which require to be strengthened. soil sample having L/D ratio 62.50,93.75,125.00 are strengthened by using different percentage 8% , 10% ,12% of steel fiber. Various tests were conducted to analyze the effect of steel fiber. Results shows That 10% of steel fiber of (L/D) 93.75 Ratio (3cm length) gives maximum improvement in desired soil strength.

I. INTRODUCTION

soil stabilization is used to improve strength and reduce settlement of weak/poor soils. construction of any structure on soft (weak) soil or loose soil is difficult so it is desirable to strengthen the soil to increase the load carrying capacity and reduce settlement of poor soil this could be achieved by soil stabilization. It increases the shear strength of soil and control the shrink swell properties of soil thus improving strength and reducing settlement Stabilization can be used in highway pavement for subgrade material if subgrade material is weak/poor soil. From expansive clay to granular material the most common improvement is done through stabilization which relates in better soil gradation,reduction of plasticity index or swelling potential, settlement and increase the durability and strength. The benefits of stabilization also include reduction settlement, plasticity, permeability, and pavement thickness which ultimately result in reduction of project cost.

Fiber is divided into three categories-one is natural fiber like wheat straw ,coir ,bagasse , sisal , and jute etc. second is synthetic fiber such as polypropylene , polyvinyl ,nylon, etc and the last is industrial fiber like steel fiber etc.they have high tensile strength ,better corrosion resistence and durability .

The fiber increase the mechanical properties of poor soil by means of interface friction between fibers and soil particles . the addition of less fiber could not create significant friction effect , whereas the excess fibers had an adverse impact on strength and deformation of soil .hence the fiber content and fiber length are key parameter associated with the mechanical properties of fiber-soil .

These techniques of soil stabilization is used in many projects dealing with different type of construction but most frequently it is used in pavement construction, where the main objective is to attain the stability and to reduce the overall cost of construction. Most commonly used materials were lime and cement but due to their increased cost and curing requirement it is becoming uneconomical to stabilize soil with them. hence the use of waste material as stabilizer is subjected to matter of research several scientist are involved in research to utilize waste material like wheat straw, rice husk, jute fiber, etc As a stabilizer for soil. present study deal with the use of industrial waste like steel fiber as a stabilizer for soil.

This study concentrates on obtaining the optimum percentage of steel fiber and optimum length of steel fiber by observing the effect of steel fiber on strength of the soil. To understand the effect of steel fiber on the soil following test were conducted: atterberg's limit,specific gravity, standard proctor test, etc.

II Material and testing methods

1.Test plan

The test include the determination of optimum fiber content and optimum fiber length by standard proctor test. based on previous researches the fiber content is taken to be 8% ,10% ,12% initially for the study and sample diameter is fixed at 0.32mm. The sample are prepared for non reinforced soil and steel fiber- soil with different percentage of steel fiber.

2.Soil

Black cotton soil (clay soil) which is quite common in vidisha district of Madhya Pradesh is used in this study. Soil sample was obtained from a field at a depth of about 0.5m. Black cotton soil are mostly clay soils and form deep cracks during dry season. It is black in color due to presence of iron and aluminum. The soil is deficient in nitrogen, phosphoric acid and organic matter but rich in calcium potash and magnesium.

Table1.1 Obtained physical Characteristics of the black cotton soil.

Physical properties	**Value(%)**
Natural water content	8.58%
Liquid limit	42.05%
Plastic limit	23.42%
Plasticity index	18.63%
Specific gravity	2.40

Table1.2 Chemical compositions of black cotton soil:- [From. Mishra brajesh IJSR(2013)]

S.NO	Properties	Value
1	pH value	>7(Alkaline)
2	Organic content	0.4 – 204%
3	$CaCO_3$	1- 15%
4	SiO_2	50- 55%
5	SiO_2 Al_2O_3	3-5%
6	Montmorrilonite Mineral	30-50%

Black cotton soil consists of clay minerals like Montmorrilonite, Illite and Kaolinite, chemicals like iron oxide and calcium carbonate (in the form of kankars), and organic matter like humus. Montmorrilonite is the predominant mineral of Black cotton soils. The swelling and shrinkage behavior of black cotton soil originate mainly from this mineral are hydrous silicates of aluminum and magnesium.

3. **Steel fiber**

Worldwide demand for steel is increasing at a rate of about 5% per annum. Annual consumption is now well over 20 million tons and is rising in areas such as the construction industry and household appliances. As the annual consumption is over 20 million ton the steel industries produces a lot of steel waste. The uses of steel industrial waste like (steel fiber) are being continuously explored in various construction work as it has corrosion resistance, longer life as compare to other fiber and it strengthening the existing structure. Steel fiber have greater resistance to corrosion and needs low maintenance. These factors mean steel fiber can be more economically viable once service life and life-cycle costs are considered. Recent advancements in metal fibers have introduced a promising new type of steel fiber with high stiffness, high failure strain. The steel fiber which is being used in this study is 0.32 mm in diameter and circular in cross-section with smooth surface and having melting temperature of 1400^0c and is heat treated. Steel fiber is a industrial waste which is easily available from steel industries. However steel is known to be susceptible to pitting corrosion.

Table1.3 Properties of steel fiber

Cross – section	Circular
Diameter(mm)	0 .32
Melting temperature	1400^0 c
Surface	Smooth
Heat treatment	Annealed(soft)

Fig 1.0 Steel fiber

Fig1.1 Soil + steel fiber sample

III.Methods of testing:-

1.Preparation of sample:- The collected natural soil is brought in the laboratory. It is spread on the ground and allowed to dry at room temperature and break lumps present in soil sample to get uniform size of soil. Now after drying the soil at room temperature its natural moisture content is determined by oven dry method.

IV. Result and discussion:-

Table4.1 Dry density variation for different length of steel fiber :-

Determination no	1 2cm steel fiber	2 3cm steel fiber	3 4cm steel fiber
(1)Mass of mould + compacted soil (gm)	5175	5270	5200
(2) Mass of compacted soil w1 (gm)	2195	2290	2220
(3) wet density (yt= wt/v) (g/cc)	2.19	2.29	2.22
(4) Water content %	11.38	11.86	11.50
(5) Dry density Yd = Yt/ (1+W) g/cc	**1.97**	**2.05**	**1.99**

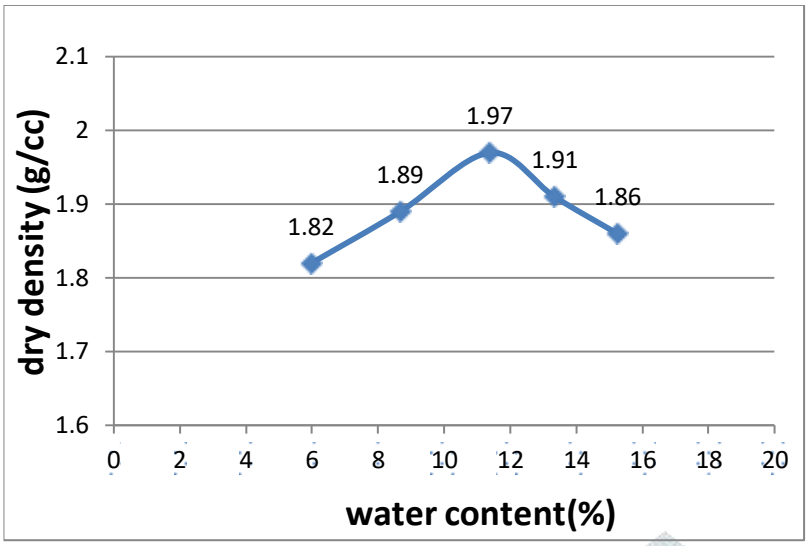

Fig.4.1 2cm length steel fiber

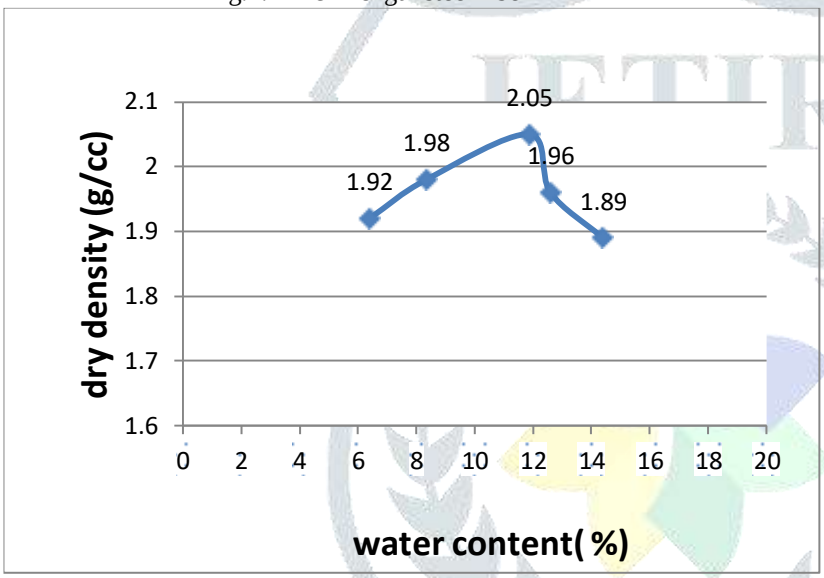

Fig.4.2 3cm length steel fiber

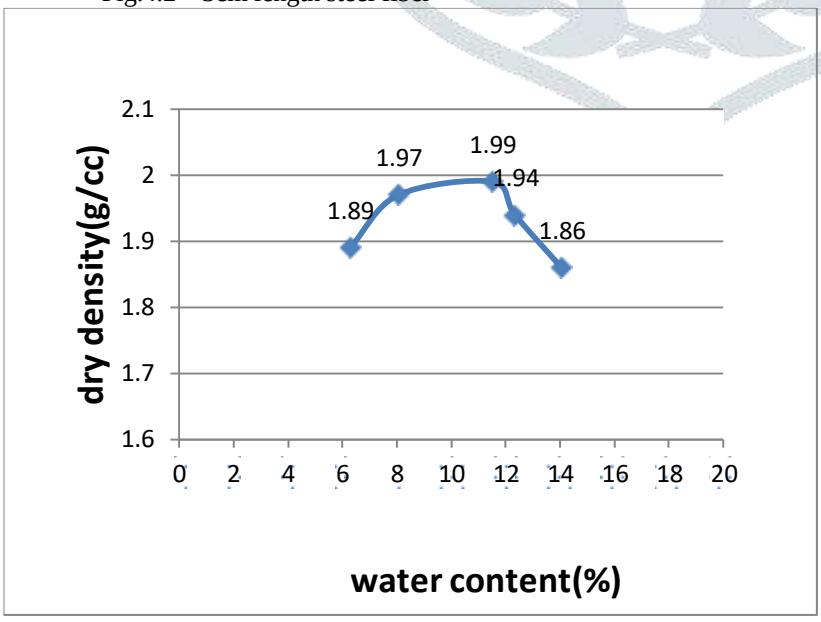

Fig.4.3 4cm length steel fiber

Hence:-

Optimum length of fiber is 3cm

Table4.2 Dry density variation for different percentage of steel fiber :-

Determination no	1 8% steel fiber	2 10% steel fiber	3 12% steel fiber
(1)Mass of mould + compacted soil (gm)	5160	5270	5195
(2) Mass of compacted soil w1 (gm)	2180	2290	2215
(3) wet density (yt= wt/v) (g/cc)	2.18	2.29	2.21
(4) Water content %	12.96	11.86	14.10
(5) Dry density Yd = Yt/ (1+W) g/cc	**1.93**	**2.05**	**1.94**

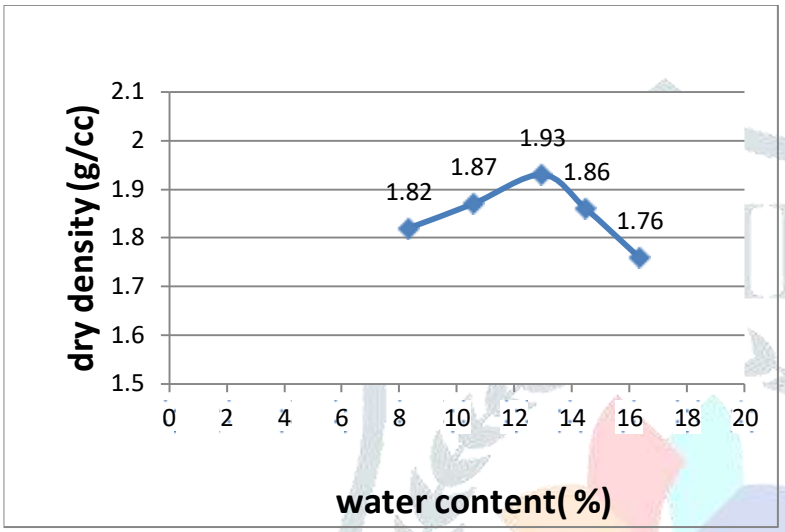

Fig 4.4 8% steel fiber 3cm length

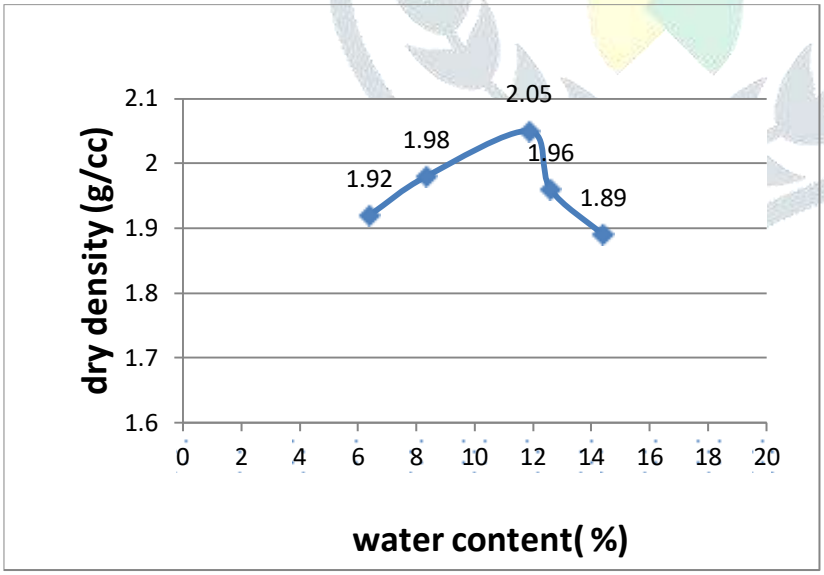

Fig 4.5 10% steel fiber 3cm length

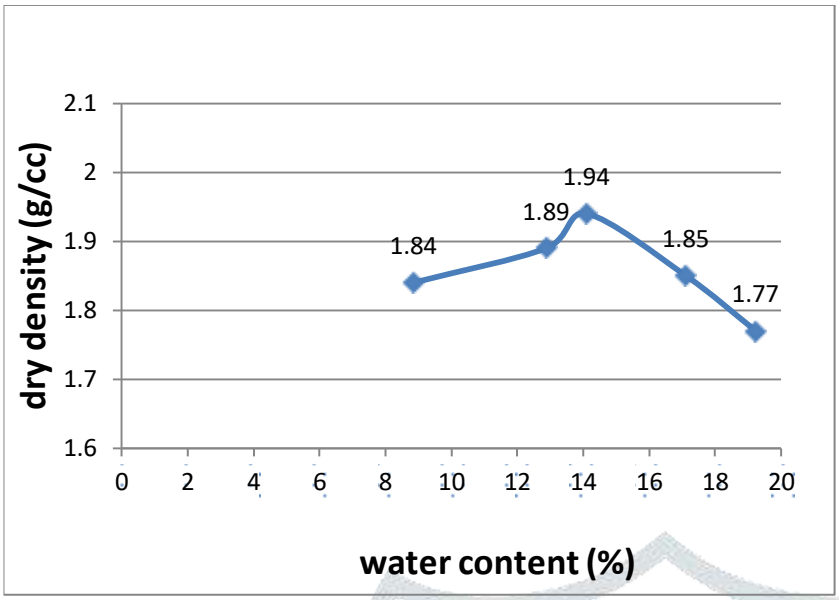

Fig.4.6 12% steel fiber 3cm length

Hence :-

Optimum fiber percentage = 10%

V. Conclusion:

Three different percentage 8%,10%,12% and different length 2cm, 3cm,4cm and 0.32mm diameter and having L/D ratio 62.50,93.75,125.0, of steel fiber were added to soil amongst them the sample with 10% of steel fiber having 3cm length steel fiber gives the most suitable mechanical properties.

VI. REFRENCES:-

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