A STUDY OF SOIL AND SOIL STABILIZATION WITH ENVIRONMENTAL WASTE (COIR FIBER AND E-WIRES)

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Abstract : *In this research work, soil stabilization is done with the help of coir fibers and E-wires simultaneously in various proportions. First, properties of soil sample which is locally extracted are found out and then Optimum percentage of coir fiber is found with that soil sample on which soil is effectively compacted. After, getting the optimum percentage of Coir fiber, various proportions of E- wires are added in the stabilized soil and changes in the properties of stabilized soil are studied finally. The optimum percentage of soil, when added with coir fiber only is 2% and then further stabilization is done by mixing E wires in different proportion i.e. 3%, 5% and 7%. Engineering properties like optimum moisture content, maximum dry density, CBR values of stabilized soil determined respectively.*

***IndexTerms* - Local soil, Coir fiber, E-wire and their proportions.**

I. INTRODUCTION

Stabilization is a term being discussed with increasing frequency at every gathering of highway or paving engineers. Soil is the basic foundation for any civil engineering structures which is required to bear the loads without failure. In some cases, soil may be weak which cannot resist the loads, soil stabilization is needed.

Types of Fiber

1). Natural Fiber :- since the non-renewable sources will extinct one day, the pollution has overshadowed everything there is need of much eco-friendly and long lasting resource. The natural fiber reinforcement takes its motivation from plants. The expansion of plant roots, isolation of plants and their age are some of the determining the performance of the natural fiber. Various types of natural fibers used in soil reinforcement are:

- Coconut (Coir fibers)
- Sisal fibers
- Palm fibers
- Jute
- Bamboo

2). Synthetic fiber

- Polypropylene fibers (PP)
- Polyester fibers (PET)
- Polyethylene fibers (PE)
- Glass fibers
- Nylon fibers

II. Material used in the Research Work

- Natural soil

These are Environmental Waste. The materials used in this study are:

- Coir Fiber waste
- Waste Electric Wire

1. Natural Soil

The natural soil is collected from Ahmadpur Road, Vidisha (M.P.) behind the SATI college and was air-dried, sieved and tested in SATI geotechnical laboratory. A variety of tests were performed on soil to find out its index properties and also the effect of soil after mixing additives.

2. Coir Fiber

Coconut coir is a natural fiber extracted from the husk of coconut [1]. It is the fibrous material found between the hard, internal shell and outer coat of a coconut [1]. The main advantage of using coconut coir is improving the strength of soil sub grade is they are cheap, locally available ad eco friendly [1].

Coir or coconut fiber belongs to the group of hard structural fibers [2]. The coir fiber is elastic enough to twist without breaking and it holds a curl as through permanently waved [2]. The inclusion of fibers had a significant influence on the engineering behavior of soil-coir mixtures [4]. In India, Coconut fibres is found in abundance as a waste product in many religious places, industries which uses coconut as a raw product etc.

fig. 1: coir fiber

Table 1: Properties of coir or coconut fiber

S No.	Description	Value
1.	Diameter	0.5 mm
2.	Length	30 mm to50 mm
3.	Specific Gravity	1.3

Table 2: Physical Properties of coir fiber

Length in inches	6-8
Density (g/cc)	1.20 to1.4
Breaking Elongation %	30%
Diameter in mm	0.1 to 0.5
Rigidity of Modulus	1.892 dyne/cm^2

3. Electric Wires

The electric wires which are generally used in electrification are used in this research work. These wires are coated with polypropylene fibers. Polypropylene fiber is one of the most common synthetic materials used for reinforcing soil due to its non-toxicity, corrosion resistance and high tensile strength.Electrical wire is basically a semi-conducting metal wrapped in a plastic insulation. Depending on the wire being recycled the conductor metal may also be aluminum or silver. This material can be tedious to separate and many companies that scrap this material don't have time to recycle it [5].

These waste electrical wires are used in our research work for studying as a stabilizer in soil stabilization and study its effect on expansive soil as an alternative way of reducing e-waste from environment. As the burning of electrical wires in open areas or in incinerators for removing copper metal extracts green house gases too which are harmful for our environment [23].

- Some of the properties of E-wires were :

table 3: properties of waste e-wires

Aspect ratio (length / diameter)	2:1
Average diameter	1.60 mm
Average length	3.5 mm
Specific Gravity	2.46
Unit weight	1200 Kg/m^3

fig. 2: waste e-wires

III. RESEARCH METHODOLOGY

The natural soil is collected from Ahmadpur Road, Vidisha (M.P.) behind the SATI college and was air-dried, sieved and tested in geotechnical laboratory, SATI College, Vidisha. Different tests were performed on soil to discover its index properties and also the effect of soil after mixing additives (Coir fiber and E- wire waste).

Since there are very wide differences in soil types, soil classification has become very important especially for the field of geotechnical civil engineering. "Index properties" is a type of classification that is based on classification and identification of soil properties. Typical examples of index properties are; Specific gravity, liquid limit, plastic limit, and Plasticity index.

The different tests were conducted in order to determine the different characteristics and properties of the local soil with and without additives. The procedure of each of the tests has been described below.

1). Preparation of material:

Local Soil is collected from site and brought to soil lab and spread for air drying. After this, screening of soil is done to sort out the organic matter, coarser particles, grass twigs etc. After this index properties of soil are found and then mixing of E-wires is done. For mixing the E-wires to the soil, steps to be follow:

- Compaction of all soil samples were done at their respective maximum dry density (MDD) and optimum moisture content (OMC), equivalent to the standard proctor compaction tests.
- Then, Soil is mixed with coir fiber at different proportions (i.e. 1%, 2% and 3%) to find out the optimum percent of coir fiber with respected soil sample. After finding the optimum percent of coir fiber with local soil which is 2% in our case, waste E- wires with 2% coir fiber is mixed with soil sample simultaneously and finally different values adopted in the present research work for the percentage of E-wires are ;
  - Soil + 2% Coir fiber + 3% E-wire
  - Soil + 2% Coir fiber + 5% E-wire
  - Soil + 2% Coir fiber + 7% E-wire
- In the preparation of samples, if fiber (Coir and E- wires both) is not used then, the air-dried soil sample was mixed with an amount of water only that depends on the OMC of the soil.
- If fiber reinforcement (Coir fiber and E-wires) was used, the adopted content of fibers was first mixed into the air dried soil sample in definite proportions by hand or by trowel, making sure that all the fibers were mixed thoroughly, so that a nearly homogenous mixture is obtained, and then the essential water was added.

2). Various Test Involved In Research Work

- Natural Moisture Content [IS 2720 (part II)-1973]
- Wet Sieve Analysis [IS 2720 (Part 4) – 1985]
- Liquid Limit Test [IS 2720 (Part 5) – 1985]
- Plastic Limit Test [IS 2720 (part 5) – 1985]
- Specific Gravity Test [IS 2720(part III)-1980]
- Compaction Test [IS 2720 (part VII) – 1980]
- California Bearing Ratio (CBR) Test [IS 2720 (Part 16) – 1987]

IV. RESULT AND DISCUSSIONS

4.1 Results of index Properties of local Soil used in this Research work:

table 4: index properties of soil

Properties	Local Soil
Natural Moisture content	**8.025 %**
Liquid Limit L.L. (%)	**39.08%**
Plastic Limit P.L. (%)	**28.03%**
Plasticity Index P.I.	**11.05%**
Specific Gravity G	**2.266**
O.M.C.	**14.7 %**
M.D.D.	**1.821 (gm/cc)**
C.B.R.	**3.8**

4.2 Results of Soil when Added with Coir Fibre and E-wires:

table 5: influences of additives with local soil

Properties	OMC	MDD (gm/cc)	CBR
Local Soil + 1% Coir Fibers	**13.70 %**	**1.864**	**5.3**
Local Soil + 2% Coir Fibers	**11.1 %**	**1.90**	**6.7**
Local Soil + 3% Coir Fibers	**12.3 %**	**1.86**	**5.8**
Local Soil + 2% Coir Fibers + 3% E-wires	**12.5 %**	**1.813**	**7.6**
Local Soil + 2% Coir Fibers + 5% E-wires	**10.9 %**	**1.87**	**8.2**
Local Soil + 2% Coir Fibers + 7% E-wires	**10.15 %**	**1.901**	**9.5**

4.3 Effect of Additives with soil:

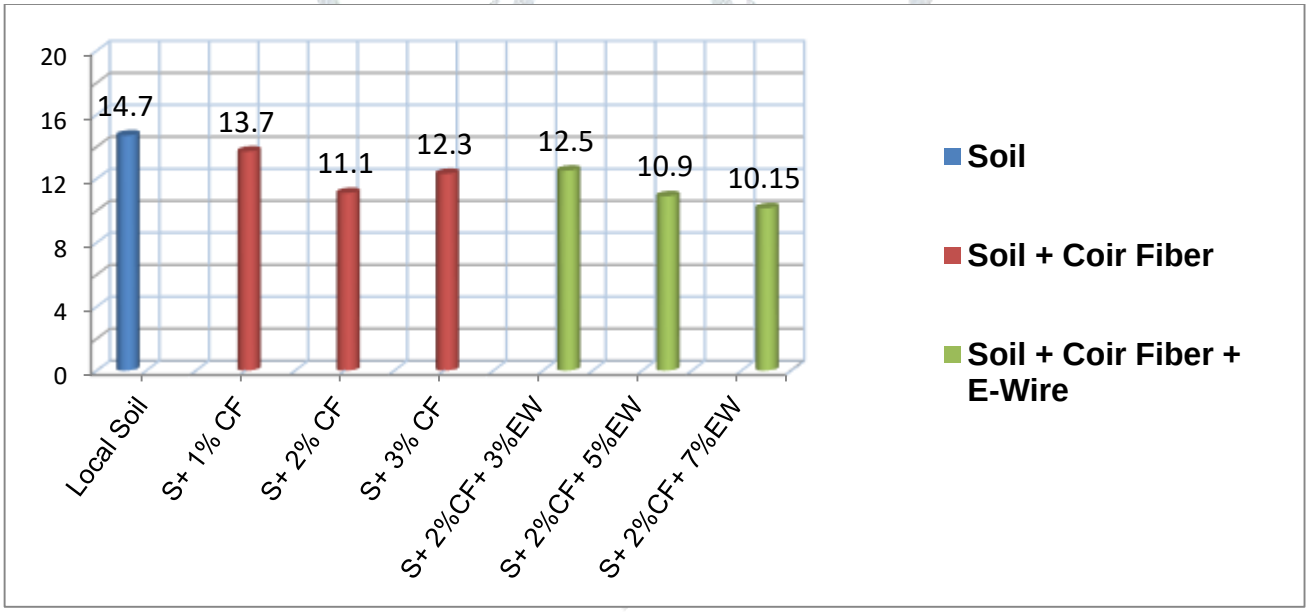

fig. 3: comparison graph of OMC of treated and untreated soil

4.4 Comparison of MDD of treated and untreated Soil

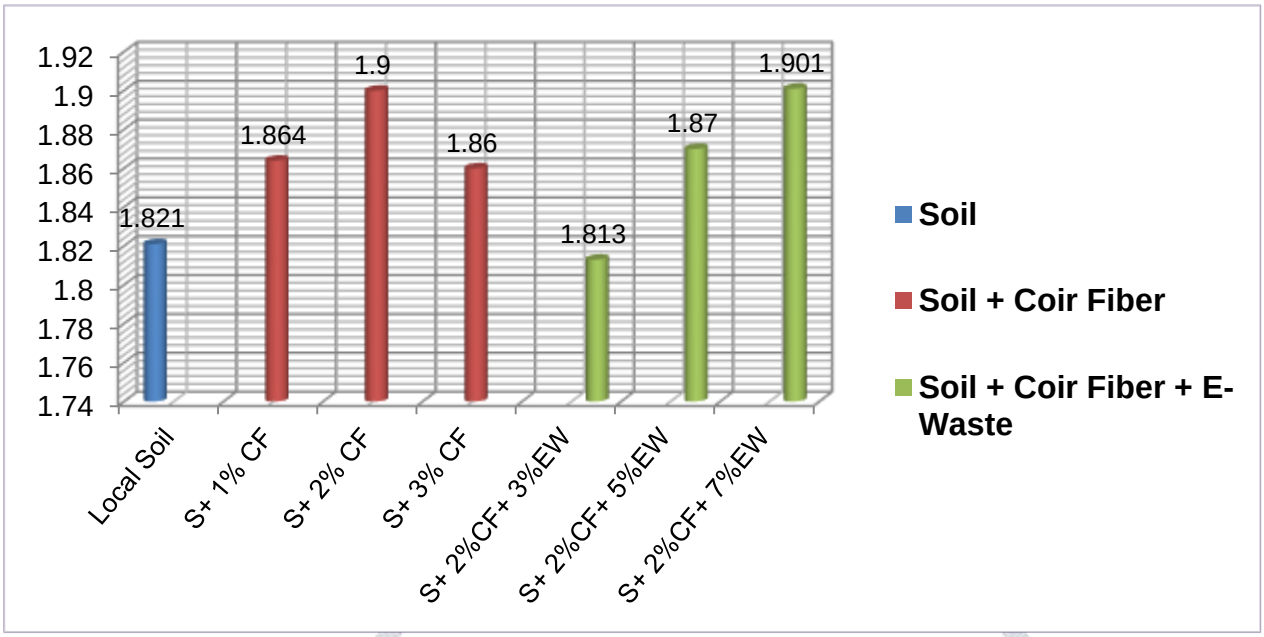

fig. 4: comparison of MDD of treated and untreated soil

4.5 Comparison of CBR values:

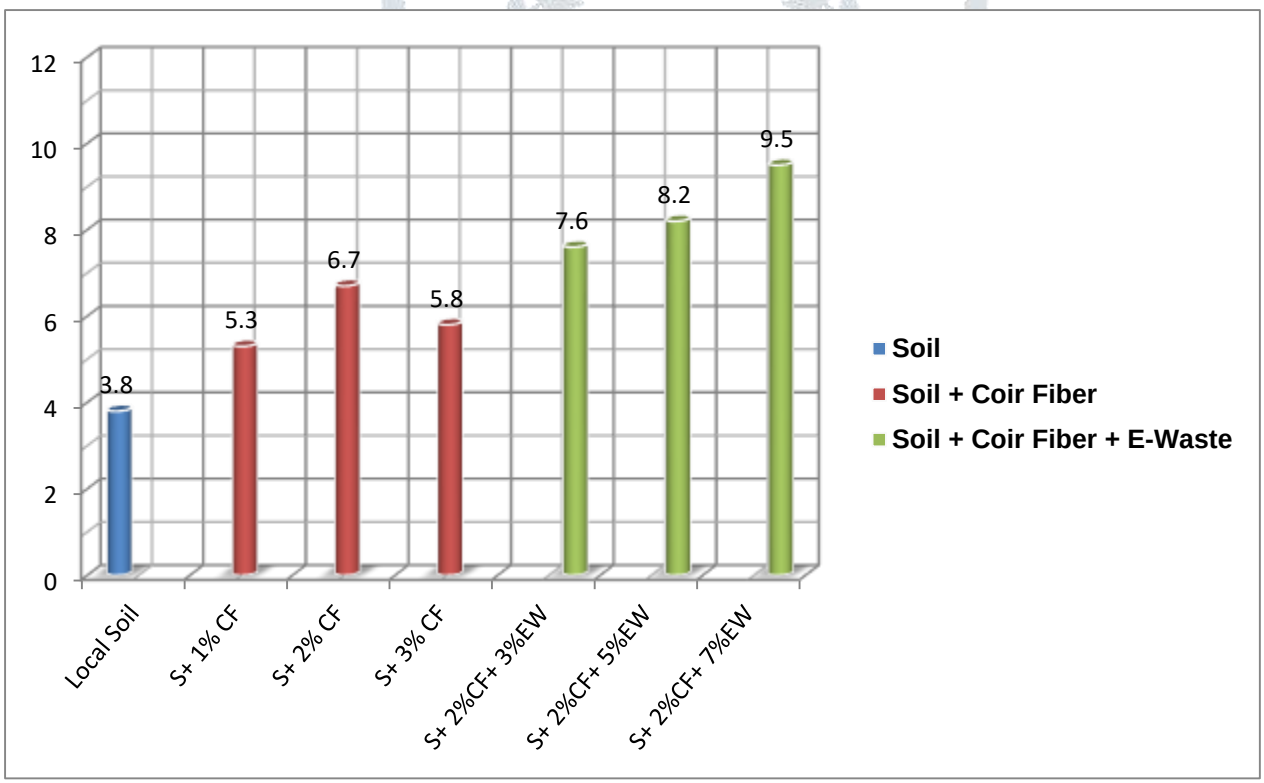

fig. 5.3 comparison of CBR values of treated and untreated soil

V. CONCLUSION

The present research study can take as an effective method to utilize waste products, Coir Fiber & E-wires in the stabilization of expansive soil. The conclusions are based on the tests performed on local Soil with optimum percentage of Coir Fiber and varying percentage of E-wires.

- The USCS classification classified the natural soil as OI (Organic Clay of medium plasticity).
- The result shows that Coir fiber & E-wires both have played a major and effective role in improving the strength characteristics performance of local soil.
- As the percent of Coir fiber & electric wires increases, OMC of natural soil decreases and MDD increases.
- Curing and compaction parameters have substantial result on strength calculated by the CBR test of the treated soil.

- Approximately 16.3% of cost reduction is seen in Coir Fiber + E-wires stabilization technique when compared to traditional (Cement) stabilization technique. Hence, economical for project works.

Maximum improvement in properties of local soil used for this study, with the combination of waste products, Coir fibers & E-wires have seen. This helps to find a purpose for Environmental, Industrial and Domestic waste to improve the properties of expansive soil both in embankments and pavement constructions and hence, helpful in reduction of cost and carbon emission. Coir fiber & E-wires have good possibility for use in geotechnical application of soils as a verified method to save time and money on construction projects and also eco-friendly in nature.

VI. FUTURE SCOPE OF THE PRESENT WORK

Following works can be recommended for future study on this research work:

- The present study is limited up to three percent only due to limited time, further the percent dosage can be increased or decreases. These three percentage are given below-
  - Soil + 2% Coir fiber + 3% E-wire
  - Soil + 2% Coir fiber + 5%E-wire
  - Soil + 2% Coir fiber + 7% E-wire
- The Coir fiber & E-wires simultaneously can also be used with other traditional stabilizer such as lime, cement and Fly-ash and with non-traditional stabilizer for more improvement of soil.
- The percentage of Coir fiber & Aspect ratio of E-wires can also change and their effect can be investigated.
- Comparison of Coir fiber & electric wire waste with other waste material which can be used as a stabilizer.

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