"ANALYSIS AND COMPARISION OF COST OF STABILIZED SOIL USING E-WASTE AND CEMENT"

Arpit Tripathi[1], Dr. Sachin S. Saraf[2], A. R. Bijwe[3]

[1]PG Student Department of civil engineering Dr. Rajendra Gode Institute of Technology & Research, Amravati MH India.
[2]HOD Department of civil engineering P.R. Pote College of Engineering & Management Amravati MH India.
[3]Professor Department of civil engineering Dr. Rajendra Gode Institute of Technology & Research, Amravati MH India.

Abstract - *In this Research work determine and compare the Engineering properties of soil such as Atterberg's limits, OMC, MDD, Shear strength parameter and CBR value of natural soil and Stabilized soil using E-waste with different proportions i.e. 5%, 7% and 9% respectively. and an estimated method for finding cost involved in soil stabilization with E-wires is compared with Cement. As Cement is the most communal stabilizer used now a day. The optimum percent for E-wires is taken as 6% for comparison purpose only, and same percent is used for estimating cement stabilization as comparison is done on same measures.*

Key Words: Cost analysis, Soil Stabilization, Waste Electric Wire, Cement, angle of Friction and CBR, etc.

1. INTRODUCTION

In Civil engineering various types of soil have to deal like weak soils, strong, soft and hard soils. It is very difficult for a civil engineer to construct any structure on soft (weak) soil or loose soil. So it is desirable to strengthen the soil to increase the bearing capacity and improve the foundation soil to address permissible settlements this could be accomplished by a technique known as soil stabilization. It increases the shear strength of soil and control the shrink swell properties of soil thus improve in strength and reduction in settlement. Stabilization can be used in highways pavement for subgrade material if subgrade material is loose/poor soil. From expansive clay to granular material the most common improvement is done through stabilization is better soil gradation, reduction of plasticity index or swelling potential, settlement and increase the durability, strength. The benefit of stabilization is to increase the strength and reduce settlement, plasticity, permeability, and reduce pavement crust, reduce excavation and transportation of loose or soft soil which ultimately cut the project cost.

Soil stabilization is also used to make an area trafficable within a short period of time for military and other emergency purpose.

The various names of soil stabilization are as follows:

1. Cement stabilization.
2. Mechanical stabilization.
3. Lime stabilization.
4. Bituminous stabilization.
5. Thermal stabilization.
6. Chemical stabilization.
7. Electrical stabilization.
8. Stabilization by grouting.
9. Stabilization by Geotextile and Fabrics.

2. Material Used

Soil: Which is locally available as mentioned above

Waste Electric wires: Reinforcement of soil was done by the electric wires which are waste material produced after the electrification of building or any other structure. Some of the properties were:

Table-1: Properties of E-wires

Aspect ratio(length/diameter)	2:1
Average diameter	1.66mm
Average length	3.32mm
Specific Gravity	2.51
Unit weight	1200Kg/m^3

3. Methodology

The several laboratory tests were performed firstly on natural (sample) soil which includes Natural moisture content, sieve analysis, Atterberg's limits, specific gravity test, Standard proctor test, Triaxial shear test and California bearing ratio (CBR) test. The California bearing ratio test were conducted on optimum moisture content.

Later on soil specimens were made by adding average length 3.32 mm (L/D 2:1) at different percentages fiber reinforcement i.e. 0%, 5%, 7% and 9% respectively and find the optimum moisture content and maximum dry density at different percentages by standard proctor test.

In the preparation of samples, making sure that all the fibers were mixed thoroughly, so that a practically homogenous mixture is obtained, and then the necessary water was added.

3.1 Various Test conducted are discussed here

3.1.1 Water content by Oven Dried method [IS 2720 part II – 1973]

3.1.2 Wet Sieve Analysis [IS 2720 part IV – 1985]

3.1.3 Specific Gravity by Pycnometer [IS 2720 part III- 1980]

3.1.4 Liquid Limit by A. Cassagrande apparatus [IS 2720 part V – 1985]

3.1.5 Plastic Limit Test [IS 2720 part V – 1985]

3.1.6 Compaction test by Proctor method [IS 2720 part VIII - 1980]

3.1.7 California Bearing Ratio test [IS 2720 (Part 16) - 1985]

3.1.8 Triaxial shear test[IS 2720 (Part XI) - 1993]

4. Results

4.1 General

On the basis of present experimental study, the following results are drawn;

E-wires have shown effective results when mixed with Natural Soil.

4.2 Atterberg's Limit

4.2.1 Liquid limit

- The liquid limit of the natural soil alone was found to be 39.08%
- The liquid limit of the soil with addition of 5%, 7%, and 9% E-wires by weight of soil is found to be 38.72%, 38.24%, and 35.41% respectively.
- The liquid limit of soil decreases when 5%, 7% and 9% E-wires are mixed with soil by 0.92%, 2.14% and 9.39% respectively.

4.3 Standard Proctor Test

- The optimum moisture content (OMC) and maximum dry density (MDD) of natural soil alone was found to be 13.75% and 1.85 g/cc respectively.
- The MDD of the soil with addition of 5%, 7%, and 9%, E-WIRE by weight of soil is found to be 1.86g/cc, 1.87g/cc, and 1.89g/cc respectively and the corresponding OMC is found to be 11.7%, 10.90%, and 10.20% respectively.

4.4 California Bearing Ratio (CBR) Test

- The CBR value (Soaked specimen) of natural soil alone was found to be 4.96%.
- The CBR value of the soil with addition of 5%, 7%, and 9%, E-wires by weight of soil is found to be 5.66%, 10.36%, and 12.57% respectively.
- The CBR value of soil increases with addition of 5%, 7% and 9% E-wires by 14.11%, 108.8% and 153.4% respectively.

4.5 Triaxial Shear Test

- The Cohesion(c) and angle of friction(ϕ) of natural soil alone was found to be 0.54Kg/cm2 and 260.
- The Cohesion and angle of friction of the soil with addition of 5%, 7%, and 9%, E-wires by weight of soil is found to be 0.52 Kg/cm2, 0.51 Kg/cm2, 0.49 Kg/cm2 and 290, 330 and 340 respectively.

5. COST ANALYSIS

5.1 Cost analysis of Traditional (Cement) Stabilization

Table 5.1 Analysis of Cost and Quantity of Cement in Cement Stabilization process

Optimum Quantity of Cement taken = 6%	
Cost of Cement Stabilization (Cement density = 1440 Kg/m3)	
Quantity of soil to be stabilized	10 m3
Quantity	10 X 1440 X 6/100 = 864Kg = 0.864 ton
Cost of Cement per ton (in Rs.)	8000/-
Cost of Cement Stabilization per 10 m3 (in Rs.)	0.864 X 8000 = 6912
Approximate cost of Cement Soil blending (in Rs.)	400/ m3
Cost of Cement soil blending of 10 m3	4000
Total cost of Cement stabilization	4000 + 6912 = Rs. 10,912

Above table shows the total cost of cement stabilization, which is estimated as Rs. 10,912. Other than this, there were many problems occurs during cement stabilization process on site, such as weather condition, initial setting time of cement, carbon emission due to cement content, Cracks development due to heat of hydration etc. which makes cement stabilization a non-profitable process, results cost benefit ratio will be much lesser.

5.2 Cost analysis of soil stabilization using E-wires

Table 5.2 Analysis of Cost and Quantity of E-wires in E-wire Stabilization process

Optimum Quantity of E-wires taken = 6%	
Cost of E-wires Stabilization (density of E-wires = 1200 Kg/m3)	
Quantity of soil to be stabilized	10 m3
Quantity	10 X 1200 X 6/100 = 720 Kg = 0.720 ton
Cost of E-wires per ton (in Rs.) (including purchasing, cutting and finishing)	5000/-
Cost of E-wires Stabilization per 10 m3 (in Rs.)	0.720 X 5000 = Rs. 3600
Approximate cost of E-wires and Soil blending (in Rs.)	400/ m3
Cost of E-wires and soil blending of 10 m3	4000
Total cost of stabilization using E-wires	4000 + 3600 = Rs. 7,600
Total saving in cost (for 10 m^3), in Rs.	10912 – 7600 = Rs. 3312
Total saving in cost (for 1 m^3), in Rs.	Rs. 331.2 (= Rs. 332, assumed)

The cost analysis of soil stabilization process using waste E-wires involves cost of waste wires, their cutting into specific size, soil blending cost etc.

5.3 Summary

- The approx. cost of Cement Stabilization is found to be Rs. 10,912.
- The approx. cost of Stabilization with E-wires is found to be Rs. 7,600.
- Total Saving in cost with respect to cement stabilization (10 m3) is Rs. 3,312.
- Percentage of cost reduction in stabilization process = 30%
- Other than this, there were many benefits of using E-wires in stabilization such as applicable in any climatic condition, waste reduction, environment friendly (carbon emission is negligible) and also cost effective.

6. CONCLUSIONS

The present study can serve as an effective method to utilize E-wires(copper) in the stabilization of expansive soil. The conclusions are based on the tests carried out on Natural Soil with varying percentage of E-wires;

- The USCS classification classified the natural soil as OI (Organic Clay of medium plasticity) As per IS:1498-1970
- The result shows that E-wires have played an important role in improving the shear strength characteristics.
- The liquid limit of natural soil when added with E-wires is decreases from 39.08 to 35.41(at 9% wire). according to MORT&H clause 305.4.4 the material used for backfill shall not be having liquid limit more than 40.
- As the percent of electric wires increases, OMC of natural soil decreases and MDD increases. As per IRC:36-2010 the dry unit weight is not less than 15.2 KN/M3.

- The compaction parameters have considerable effect on strength measured by the CBR test of the treated soil with time and have to be taken in account during foundation works.

  The CBR of soil increases from 4.96% to 12.57% (at 9% of wire) which is suitable for Subgrade work or lower the pavement thickness as per sound Engineering and design practice.

- The Angle of friction increases from 260 to 340 (at 9%wire). As per IRC:SP:102-2014, The minimum value of reinforced soil/fill is 300.

- Approximately 30% of cost reduction is seen in E-wire stabilization technique when compared to traditional (Cement) stabilization technique. Hence, economical for project works.

It has been found that there is a maximum improvement in strength properties for the combination of E-wires with Soil (at 9%). This helps to find an application for industrial and domestic waste to improve the properties of expansive soil both in embankments and pavement constructions. E-wires have good potential for use in geotechnical application of soils is a proven method to save time and money on construction projects.

7. FUTURE SCOPE OF THE PRESENT WORK

Accumulation of waste material is an important factor to look out for environment. copper wire is one of the products generated as industrial waste. As copper wire has great tensile strength it prevents cracks in stabilized soil and give ultimate strength to soil. so it can be used in pavement construction. With day by day increase in cost of cement and the amount of pollution caused by cement factories it is mandatory to look for other material to stabilized soil. The E-wires can also be used with other traditional stabilizer such as lime, cement for more improvement of soil. Copper wire is having good properties that make it an attractive alternative in future.

REFRENCES

1. Chauguke,M., Deore,S., Gawade,K., Tijare,A., Banne,S., (2017) “Improvement of black cotton soil properties using E-waste”, IOSR journal of mechanical and civil engg., Vol. 14, Issue 3 Ver.1, PP 76-81.

2. I.S.:2720 part II, (1973) “Indian Standards for methods of test of soil, test for determination of water content”, Bureau of Indian Standards, New Delhi.

3. I.S.:2720 part III, (1980) “Indian Standards for methods of test of soil, test for determination of Specific Gravity”, Bureau of Indian Standards, New Delhi.

4. I.S.:2720 part IV, (1985) “Indian Standards for methods of test of soil, test for determination of Grain size analysis”, Bureau of Indian Standards, New Delhi.

5. I.S.:2720 part V, (1985) “Indian Standards for methods of test of soil, test for determination of Atterberg’s limit”, Bureau of Indian Standards, New Delhi.

6. I.S.:2720 part VIII, (1980) “Indian Standards for methods of test of soil, test for determination of Water content/ Dry Density relation using Heavy Compaction”, Bureau ofIndian Standards, New Delhi.

7. I.S.:2720 part XI, (1993) “Indian Standards for methods of test of soil, test for determination of Shear strength parameters of a specimen tested in Unconsolidated Undrained Tri- axial Compression without measurement of pore water pressure”, Bureau of Indian Standards, New Delhi.

8. I.S.:2720 part XVI, (1987) “Indian Standards for methods of test of soil, test for determination of California Bearing Ratio”, Bureau of Indian Standards, New Delhi.

9. Pal Shish, Sonthwal Vinod K., Rattan Jasvir S., (2015), “Soil Stabilisation Using Polypropylene as Waste Fibre Material”, IJIRSET journal, Vol.4, Issue 11.

10. Punamia, B.C., Jain, Ashok K., Jain Arun. K., (2005) “Soil Mechanics and Foundations”, Laxmi publications, 16 Edition.

11. Reddy,Y.R., Reddy,T.R., (2016) "Stabilization of soil by using waste fiber materials", International journal of advanced technology and innovative research, Vol. 8, Issue 15 PP 2963-2966.

12. Rawat Abhinav, Mital Anupam (2015), "A review paper on soil stabilization using different traditional and non-traditional additives", IJRREST, Vol.4, Issue 1, ISSN 2278-6643.