Available online @ https://jjem.jnnce.ac.in
https:www.doi.org/10.37314/JJEM.2022.060205
Indexed in International Scientific Indexing (ISI)
Impact factor: 1.395 for 2021-22
Published on: 31st January 2023

Stabilization of Soil Using E Waste

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Abstract

Soil stabilization with controlled compaction and addition of admixture, considerably increases the bearing capacity of soil and stability of the soil. Soil stabilization with controlled compaction and addition of admixture, considerably increases the bearing capacity of soil and stability of the soil. In future E waste may be major problem and needs solution. An attempt was made to use the E waste in the stabilization of Clay soil with high plasticity. Optimum moisture content of E stabilized soil decreases with increase in percentage of E waste in soil. Unconfined compressive strength also increased with the increase in percentage of E waste in E waste stabilized soil.

Keywords: *E – Waste, soil Stabilization, dry density, optimum moisture content, Unconfined compressive strength.*

1. Introduction

Soil stabilization with controlled compaction and addition of admixture, considerably increases the bearing capacity of soil and stability of the soil. One of the characteristics of the Black cotton soil is it swells and shrinks with change of water content. The swelling and shrinkage behavior is more in case of clay with high plasticity.

Waste is an unusable and unwanted material. Generally, waste is generally liquid or solid. Waste is also classified into organic, re-usable and recyclable waste. Examples include municipal waste, hazardous waste, waste water, radioactive waste, electronic waste and others.

Discarded electrical and electronics devices is classified as electronic waste. E waste also includes reused, resale, recycling or disposal electrical or electronics devices. Informal processing of E-waste in developing countries can lead to adverse human health effects and environmental pollution.

Harmful components such as lead, cadmium, beryllium, or brominated flame retardants etc may present in E waste. Great care must be taken to avoid unsafe exposure in recycling operations and leaking of materials such as heavy metals from landfills and incinerator ashes.

India is a developing country and change of lifestyle from the last decades, the demand of using electronics product is increased. India is one of the largest E waste producers in the world waste. The rate of E waste generation is more than the municipal waste. In future E waste may be major problem and needs solution. Otherwise, E waste has to be dumped on a large area.

In order to overcome the problem of safe disposal and handling of E waste, an attempt was made to use the E waste in the stabilization of Clay soil with high plasticity. E waste stabilization of soil is economical as compare to stabilization of soil using cement, lime etc.

2. Literature Review

Rahul Gupta et al. (2016) studied the effect of E waste on expansive soil. 3, 6, 9 and 12% of E waste is used to stabilize the soil. The different physical and strength performance test were performed to check the performance of E waste stabilized expansive soil. The strength of
expansive soils increased by stabilizing soil with E waste. Stabilization of soil with 6% of E waste showed the Maximum soaked CBR value, maximum dry density and maximum unconfined compressive strength.

Mangesh Chaugule et al.(2017) studied the effect of E waste at different dosage on black cotton soil. Various physical and strength performance tests were conducted on soil stabilized with E waste. Unconfined compressive strength increased to 2.41kN/m2 for fixed dosage of E waste. Direct shear test showed there was an improvement in angle of shearing resistance. Both cohesion and angle of shearing resistance increases with increasing percentage of E waste in Stabilized soil.

3. Materials

Soil: The soil sample is collected from LBS nagara, Shivamogga at a depth of two meter. The properties of soil are shown in table.1.

E-Waste: E-waste is collected from the scrap stores. The E waste consists of equal proportions of PCB boards of computers, laptops and mobiles. The composition of PCB is shown in figure 1 and properties of E-Waste are shown in table.2.

4. Methodology

Methodology used in this study is as follows:

- Soil sample is collected and basic tests such as Sieve analysis, Atterberg Limits and Compaction is done to determine the properties of soil.
- Soil is stabilized with 2, 4, 6 and 8% of E waste.
- Compaction test is conducted on soil and E waste stabilized soil to know the improvement.
- Test results were analyzed, tabulated and graphs were plotted.

Table 1: Properties of Soil

PROPERTIES	VALUES
Specific Gravity	2.40
Coefficient of uniformity (C_u)	0.47
Coefficient of curvature (C_c)	6
Liquid Limit	50.5%
Plastic Limit	24.74%
Plasticity Index	23.75%
Type of Soil	CH
Optimum Moisture Content	21.94%
Maximum Dry Density	17.5kN/m3

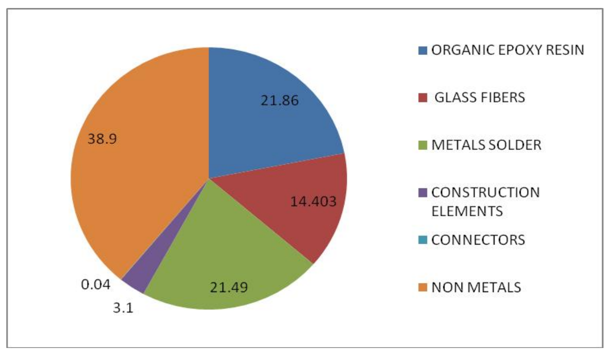

Figure 1: Composition of PCB

5. Results and Discussions

5.1 Effect of E-Waste on Dry Density

The variation of dry density and E-waste are as shown in figure 2. The dry density of E waste stabilized soil is more than the soil mass alone. The maximum dry density is 1.62kN/m^3, 1.64 kN/m^3,1.70 kN/m^3, 1.75 kN/m^3 and 1.67 kN/m^3 respectively for 0, 2%, 4%, 6% and 8% of E waste respectively. The 6% E waste stabilized soil shows maximum dry density and the improvement in dry density is about 8% as compared to unsterilized soil.

Table-2: Properties of E Waste

MATERIAL	ELEMENT	COMPUTER CONTENT (%)	LAPTOPS CONTENT (%)	MOBILE CONTENT (%)	AVERAGE
ORGANIC EPOXY RESIN	C	18.1	0	24.69	14.263
	H	1.8	0	1.38	1.06
	N	0.32	0	0.85	0.39
	O Org	6.03	0	0	2.01
	Br	5.07	0	4.94	3.336
	Sb	0.45	1.97	0	0.806
GLASS FIBERS	SiO_2/Si	24.7	0	0	8.233
	Al_2O_3	9.35	0	0	3.116
	CaO / Ca	3.36	3.2	1.9	2.82
	MgO/Mg	0.081	0.096	0.22	0.132
	BaO/Ba	0.0022	0.16	0	0.054
	NaO/Na	0.09	0.002	0	0.0306
	SrO/Sr	0.035	0.02	0	0.0183
METALS SOLDER	Cu	14.6	24.6	13.79	17.66
	Sn	5.62	2.31	0	2.643
	Pb	2.96	0.63	0	1.196
CONSTRUCTION ELEMENT	Fe	4.79	0.22	1.97	2.326
	Ni	1.65	0.11	0.17	0.643
	Cr	0.356	0.025	0.003	0.128
	Mo	0.016	0	0	$5.33X10^{-3}$
CONNECTORS	Ag	0.045	0.0242	0	0.023
	Au	0.0205	0.0076	0	$9.36X10^{-3}$
	Pd	0.022	<0.0027	0	$8.23X10^{-3}$
NON METALS		0.1	66.65	50.087	38.94

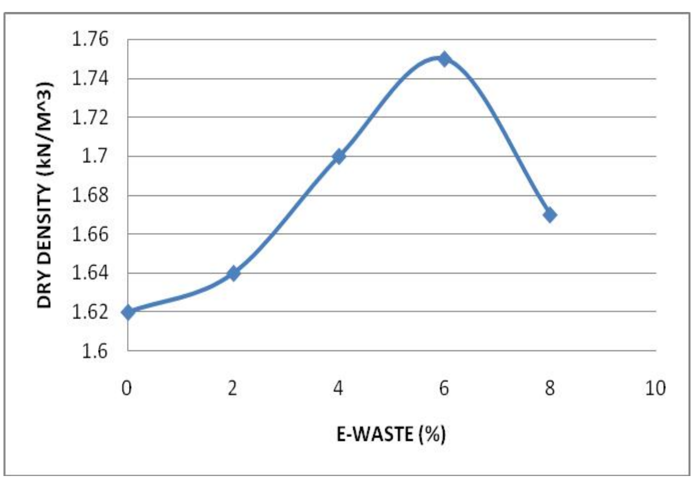

Figure. 2: Effect of E-Waste on Dry Density

5.2 Effect of E-Waste on Optimum Moisture Content

The variation of water content and E-waste are as shown in Figure 3. As the addition of E-waste increases dry density increases and at the same time optimum moisture content decreases. The optimum moisture content is 21%, 18%, 16%, 17% and 17% at 0, 2, 4, 6 and 8% E waste respectively. The 4% E waste stabilized soil shows the minimum optimum moisture content and the decrease in the optimum moisture content is about 26.98% as compared to the un-stabilized soil.

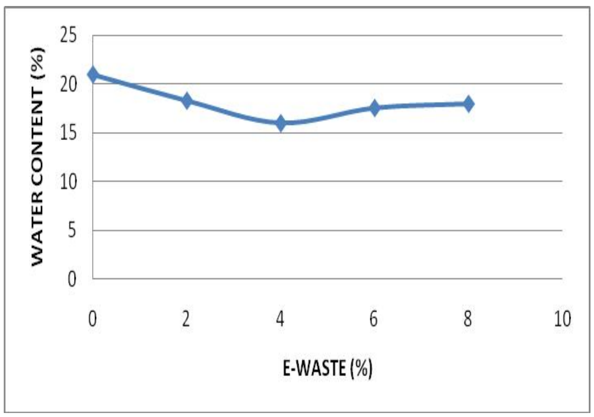

Figure 3: Effect of E-Waste on Water Content.

5.3 Effect of E-Waste on Compaction

Figure 4 shows the dry density v/s water content graph for 0, 2, 4, 6 and 8% E waste stabilized soil. The 6% E waste stabilized soil shows maximum dry density and 4% E waste stabilized soil shows minimum optimum moisture content.

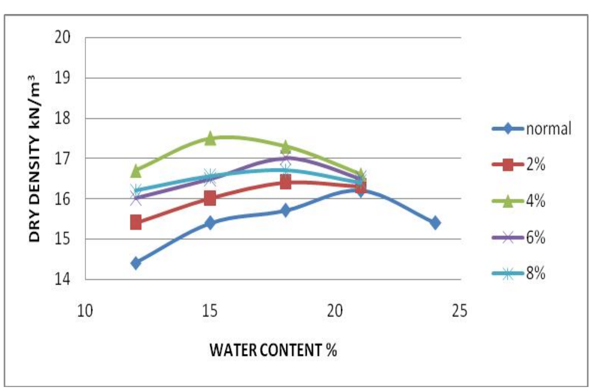

Figure.4: Effect of E-Waste on Compaction.

5.4 Effect of E-Waste on Stress Strain Behaviors

Figure 5 shows the stress strain behavior of soil and E waste stabilized soil. The maximum stress in E waste stabilized soil is greater than the un-stabilized soil. The 4% E waste stabilized soil shows the maximum unconfined compression strength and the increase in the unconfined compression strength is about 70.5% as compared to un-stabilized soil.

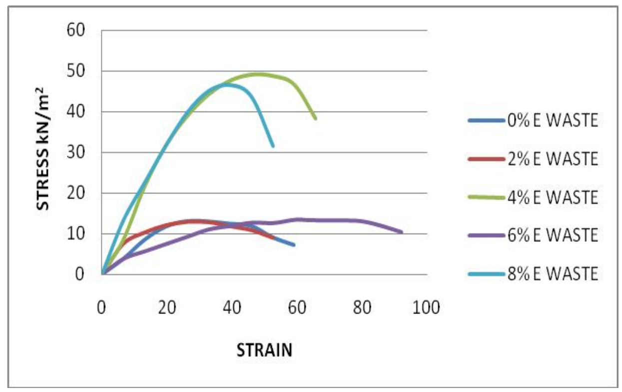

Figure 5: Effect of E-Waste on UCC Characteristics.

6. Conclusions

Following are the conclusions drawn based on the results obtained from the testing of soil stabilized with E waste.

1. The E waste stabilized soil shows increased maximum dry density and reduced optimum moisture content as compared to un-stabilized soil.
2. The 6% E waste stabilized soil shows the maximum dry density and the improvement in dry density is about 8% as compared to un-stabilized soil.
3. The 4% E waste stabilized soil shows the minimum optimum moisture content and the decrease in optimum moisture content is about 26.98% as compared to un-stabilized soil.
4. E waste stabilized soil shows increased unconfined compressive strength of soil as

compared to un-stabilized soil and maximum improvement is found at 4% E waste.

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