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USE OF E-WASTE MATERIAL FOR IMPROVING THE PROPERTIES OF BLACK COTTON SOIL

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Abstract *- The black cotton soil is used as construction material who's bearing capacity is extremely low. This soil is clayey in nature which undergoes volumetric changes with a change in moisture content, swelling and shrinkage of these soil cause damage to the pavement of road, buildings, retaining structures etc. Therefore to improve the strength properties of the black cotton soil by adding E-waste. The addition of E-waste results in increased strength and increased safe bearing capacity. Hence for improved properties soil can be used for construction purpose. Here, we are using the E-waste as engineering properties improve agent*

Keywords- *black Cotton soil, E-waste, SPT, DST, Swell index etc.*

1. INTRODUCTION

A large part of Maharashtra is covered with black cotton soils. Black cotton soil is having undesirable plasticity. Black cotton soil contains the clay mineral montmorillonite. Montmorillonite is unstable clay mineral, thus the soil have high swelling and shrinkage characteristics. It is very difficult to construct a structure or pavement of road with this soil, because black cotton soil has very low bearing capacity and it do not possesses sufficient strength to support the loads imposed upon them during the service life of the structure. Hence for improving the engineering properties if black cotton soil E-waste is used. E-waste Recycling is one of the disposal techniques, but if it is not recycled then it has to be land filled in a nearby disposal facility. So by taking this point in consideration we have adopted "The Use of E-Waste", for improving the engineering properties of the soil. In construction of pavement, engineering properties of soils is the important factor to be considered. The stability and bearing capacity of the soil is considerably improved by soil stabilization through proportioning and the addition of suitable admixtures. Swelling of soil is not suitable for the construction work on account of its volumetric changes. Soil swells and shrinks excessively with change of water content. Such tendency of soil is due to the presence of fine clay particles which swell, when clay particle come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of pavement takes place. In India this Expansive soil is called as 'black cotton soil'. Colour of this oil reddish brown to black and this helps for cultivation of cotton, so is called black cotton swelling soil covers about 30% of the land area in India. They are also commonly known as expansive, bentonite or BC soil.

OBJECTIVES

1. To study the effect on properties of BC soil due to E-waste material.
2. To study the effect on SBC of soil by using E-waste.

2. Materials and Methods

Black Cotton Soil

The materials used for this tests include the black cotton soil and E-waste. The soil was procured from the agricultural area of Indapur region District. Pune. We were used for the procurement of soil. Bigger size lumps were broken down with rammers. Then it was oven dried for 24 hours at 105 °C to 110°C.

Fig no.01 black cotton soil

E-waste

Electronic waste may be described as the discarded electronic equipment's such as mobile phones, computer parts; household appliances which fail or are no more fit for its originally intended use. Around the world 50 million tons of E-waste is generated annually around the globe. Developing countries like India are being used to dump large amount of E-waste without its sorting or dismantling. It is used by crushing it from Akluj, Panchavati Nagar.

Fig no. 02 E-waste crushed and without crushed

3. Methodology of Work

- Collection of material (black cotton soil and E-waste material)
- Crushing of collected E-waste material in crushing machine
- finding basic properties of BC soil and E-waste material
- experimental work on different black cotton soil and e-waste material combination
- Analysis of result
- Comparison
- conclusion

4. Different Test Conducted on BC Soil With E-Waste and Without E-Waste

1. Moisture content
2. Specific gravity
3. Consistency limit
4. Standard proctor test
5. Direct shear test
6. Free swell index

5. Different Engineering Properties of Black Cotton Soil Calculated

Table no 01 engineering properties of BC soil

Sr. no	Name Of Test	Result Obtained On BC soil
1	Moisture Content (%)	12.88
2	Specific gravity	2.48
3	Consistency limit LL (%) PL (%) IP (%)	 58.40 50.56 7.84
4	OMC (%)	16.67
5	MDD (kg /m^3)	1.32
6	SBC (ton/m^2)	19.89
7	Swell index (%)	100

6. RESULTS

After the calculation of basic properties of black cotton soil, soil properties improved with E-waste and the strength parameters like C & Φ, MDD and OMC were determined by conducting direct shear and compaction tests. Following are the results obtained after performing tests.

1. Specific gravity

Table no 02 specific gravity

Determination	0%	2%	4%	6%	8%
Wt. of Pycometer (W1)	452	440.5	473	485	474
Wt. of Pycometer + wt of dry soil (W2)	652	640.5	672	678	674
Wt. of Pycometer + dry soil+ water (W3)	1327.5	1322	1349	1366	1352
Wt. of Pycometer + water (W4)	1208	1188	1211	1227	1225
Specific gravity	2.484472	3.030303	3.262295	3.574074	2.739726

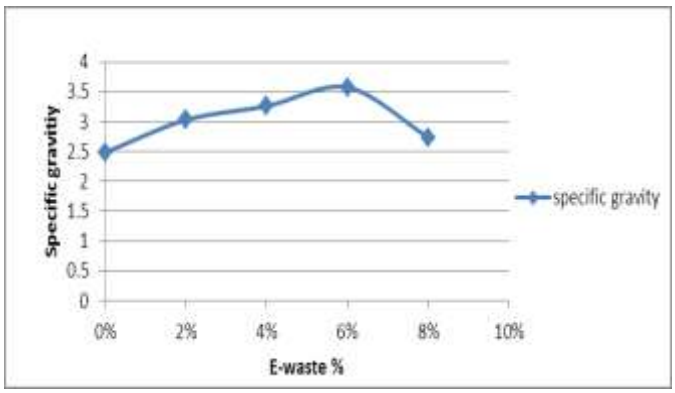

Fig no. 03 specific gravity vs. E-waste %

2. Consistency Limit

These are the basic limit of water contents of soil i.e. its liquid limit, plastic limit and shrinkage limit. After performing tests for liquid limit and plastic limit with and without addition of E-waste; soil undergoes distinct changes in behaviour. Following are the results calculated for liquid limit, plastic limit and plasticity index.

Table no 03 consistency limit

LL	PL	IP	E WASTE
58.40%	50.56%	7.84%	0%
58.50%	54.22%	4.28%	2%
72%	55.56%	16.44%	4%
65.80%	62.18%	3.62%	6%
58.50%	50.12%	8.38%	8%

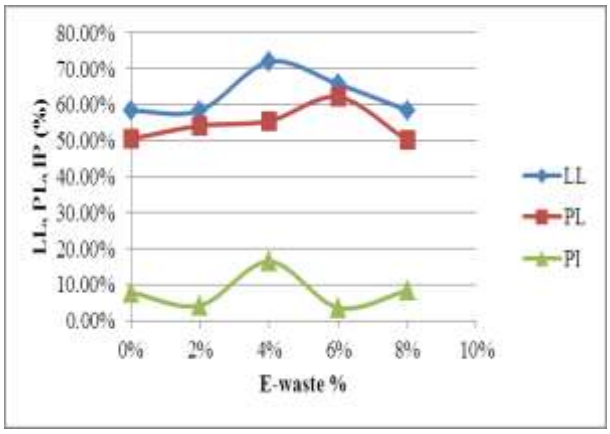

Fig no 04 LL, PL, IP vs. E-waste%

3. Standard Proctor Test

Standard proctor test were performed with and without E-Waste .Following are the result tabulated in table 3 which shows OMC and MDD for respective specimens.

Table no.04 OMC &MDD

Sr. No.	SAMPLE	OMC (%)	MDD (kg/m3)
1	Black Cotton Soil	16.67	1.32
2	Black Cotton Soil + 2% E-waste	16.52	1.3
3	Black Cotton Soil + 4% E-waste	16	1.26
4	Black Cotton Soil + 6% E-waste	13.88	1.24
5	Black Cotton Soil + 8% E-waste	24.24	1.07

The variation in OMC and MDD can be figured out from the figure OMC and MDD curves are plotted for each specimen.

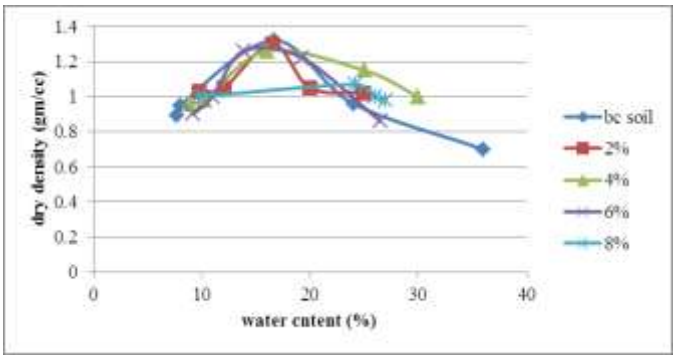

Fig no 05 Dry density vs. water content

We can see that the addition of E-waste increases, MDD increases and OMC decreases. For 8% of E-waste MDD decreased and OMC increased. Following figure 7 shows the direct relationship between MDD and E-waste.

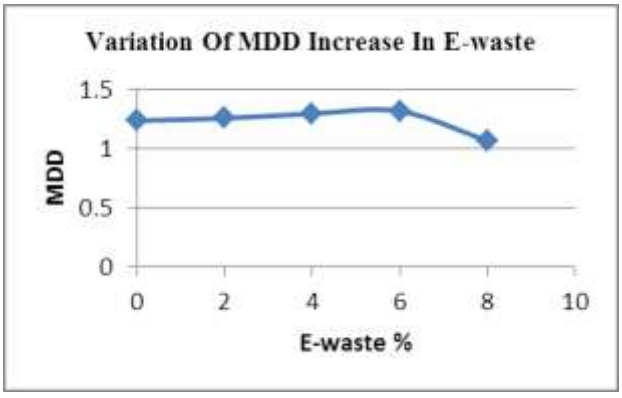

Fig 06: Variation of maximum dry density with addition of E-waste.

4. Direct Shear Test

BC soil to determine the cohesion (C) and angle of internal friction (Φ).Variation in Shear Strength parameter can be observed in fig .with the addition of E-Waste

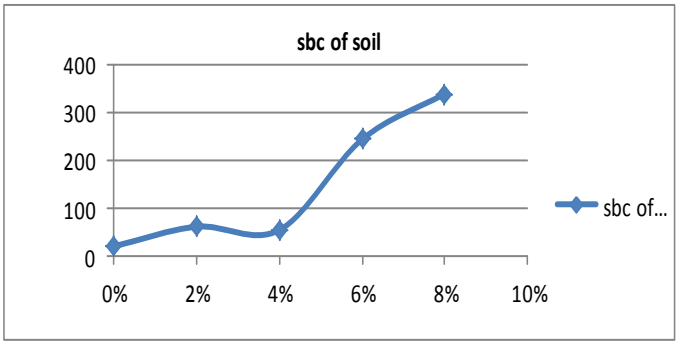

FIG 07: VARIATION OF ANGLE OF FRICTION WITH ADDITION OF E-WASTE

5. Free swelling index

Table no 05: Swell Index

Determination No	BC soil	2%	4%	6%	8%
Mass of Dry soil passing 425µ Sieve (gm)	10	10	10	10	10
Volume in Water after 24 hrs swell (Vw) (cc)	2	7	14	16	14
Volume in Kerosene after 24 hrs (Vk) (cc)	1	4	10	12	11
Free swell Index [(Vw-Vk)/Vk*100] (%)	100	75	40	33.33333	27.27273

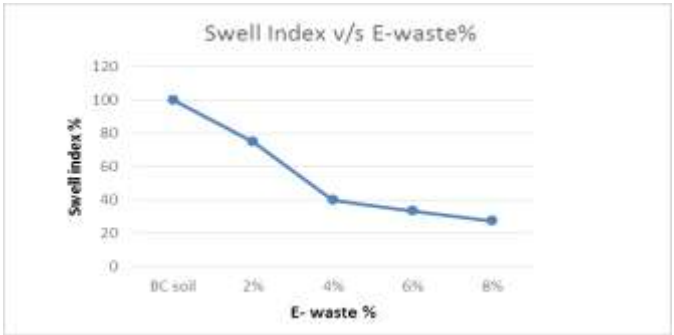

Fig No 08 Swell Index VS E-Waste %

From the figure, it can be seen that the angle of internal friction (Φ) is directly proportional to percentage addition of E-water because the addition of E-waste % increases swell index decreases. Hence, low the swell index less will be the swelling of soil. Addition of E-waste thus reduces the swelling of the soil which is one of the good characteristic of soil

7. CONCLUSIONS

Based on the experimental work carried out in the study the following conclusions are drawn for investigation of BC soil properties.

[1] Specific gravity increased up to 6% addition of E-waste but decrease for 8% addition of E- waste and plastic limit increased up to 6%and decreases at 8%of E- waste. Liquid limit increased up to 6% and suddenly decreased at 8%.

[2] After performing direct shear test, the angle of friction(Φ) decrease and ultimately cohesion (c) increases due to reduction of cohesion of soil increase the SBC of soil after adding of E-waste

[3] MDD increased and OMC decreased for 2%, 4% and 6% as the voids in the soil were filled by E-waste which results in dense soil. MDD gradually decreased for 8% of E-waste.

[4] It is observed that free swell index values of the soil have decreased with increase in E-waste.

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