Study of UCS Behaviour of Waste HDPE Plastic Strips Reinforced Soil

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Abstract- *The performance of road pavement is often poor after every monsoon and shows cracking, potholes, differential settlement at various locations etc. In Maharashtra most of the part is covered by BCS. The BCS is hard when dry, but loses its strength with rise in moisture content. Stability of BCS is an acute problem that poses several challenges. Generally, the problematic soils are either to be removed and replaced by better quality material or stabilized using additives. Demonstrate the potential of reclaimed waste pipe high density polyethylene strips (HDPE) as soil reinforcement for improving engineering performance of sub grade soil. HDPE strips obtained from waste were mixed randomly with the soil. A series of Unconfined Compressive Strength (UCS) test were carried out on randomly reinforced soil by various aspect ratios and percentage of HDPE strips. The feasibility of adding HDPE waste plastic is concluded for improving the engineering properties of Black Cotton soils. The optimum fiber content corresponding to maximum improvement in UCS was found to be AR 4 of 5%.*

Keywords- BCS, HDPE, UCS.

I. INTRODUCTION

Generally, lands with Black cotton soils are fertile and good for agriculture purpose. In India black cotton soil covers about 20% of the total land. The BCS is hard when dry, but loses its strength as well as increase volume with rise in moisture content. Due to this unique behavior many structures constructed on expansive soil severely distressed. In order to overcome such type of problem there is a need to stabilize the soil. Various methods are used to improve the engineering properties of expansive soils. The problematic soils are either treated using additive or removed and replaced by good quality material. The stabilization of problematic soils is very important for many of the geotechnical engineering applications such as pavement structures, building foundations etc. to avoid damage due to settle of soft soil or to the swelling action of expansive soil. Stabilization broadly defines various methods employed for modifying the properties of soil to improve its engineering performance. The main objective is to increase stability of soil and reduces construction cost by making best use of locally available materials. Stabilization can be done by using admixtures like cement, lime, fly ash, chemicals, reinforcing material like fibers, strips in different proportions. Nowadays, plastic containers generally made up of high density polyethylene (HDPE) are being increasingly used for storage of various liquids. Most of these containers are specifically having short life span and are being discarded immediately after use. Though, at many places HDPE is being collected for recycling or reuse. The quantity of HDPE that is being currently reused or recycled is only a fraction of the total volume produced every year. The best way to handle such wastes is to utilize them for engineering applications. Soil reinforcement technique used to improve the strength of sub grade soils. This technique has been found effective and reliable method to improve the strength of sub grade soils.

II. BACKGROUND

Soil fiber composites have been found effective in improving the CBR value as reported in the literature. In addition, use of polyethylene fiber (plastic waste) improved ultimate strength of both reinforced and un-reinforced soil. Strength and load bearing capacity of soil was enhanced considerably when the soil is stabilized mechanically with short thin plastic strips of different length and content. The feasibility of reinforcing soil with strips of reclaimed high density polyethylene has also been investigated to a limited extent. It has been also reported that the presence of a small fraction of HDPE fiber can increase the fracture energy of the soil. In view of the above limited studies, present study has been taken up with special reference to its feasibility for application in embankment/road construction.

III. MATERIAL USED

Black Cotton Soil –

Natural black cotton soil was obtained from Mhasawad, Jalgaon district in Maharashtra state. The soil was excavated from an approximate depth of 1.0 m from the natural ground level. The soil is dark grey to black in colour.

Sr. No.	Parameter	Values Obtained
1	Specific Gravity	2.603
2	Natural Water Content	18.88
3	Liquid Limit	58.58
4	Plastic Limit	40.16
5	Plasticity Index	18.42
6	Shrinkage Limit	10.69
7	Swelling Index	37
8	MDD	1.432
9	OMC	22.94

HDPE-

HDPE plastic pipe for the present investigation was collected from the Supreme Pipe factory located in Gadegaon Jalgaon district was used as a stabilizing agent in this study. It was collected in dry form from the ware house in plastic bag.

Sr. No.	Parameter	Values or Data Obtained
1	IUPAC Name	Polyethylene or Polyethylene
2	Abbreviations	HDPE
6	MeSH	Polyethylene
7	Chemical Formula	$(C_2H_4)_n$
8	Density	0.91-0.96 g/cc
9	Melting Point	115°C - 135°C

IV. METHODOLOGY

Samples of soil and HDPE strips mixtures were prepared by mixing the desired proportions of potable water, soil and HDPE strips. A specific a width of 12mm and thickness is as much less as possible, generally 3 mm. After that selecting the size that is aspect ratio and proportion of high density polyethylene. Aspect ratio is defined as the ratio of length to width of material. These were cut into lengths of 12mm [Aspect Ratio (AR) =1], 24mm (AR=2) and 36mm (AR=3), 48 mm (AR=4), 60 mm (AR=5)] considering a different aspect ratios of high density polyethylene. The soil-HDPE strips mixtures were prepared by first thoroughly mixing dry predetermined quantities of crushed soil, HDPE strips and in a mixing trey to a uniform paste. The required amount of water determined from moistures density relationship for soil- HDPE strips mixtures was later added to the dry soil- HDPE strips. The experimental study involved performing a series of laboratory UCS tests on HDPE strip reinforced soil specimen.

V. RESULTS AND DISCUSSION

The most important parameter for the strength is UCS value. It is also an indirect method for computing soil strength. Figs.1 to 5 presents the UCS values of reinforced and unreinforced soil the most important engineering parameter to evaluate a sub-grade or sub-base materials is UCS test. Deformation of the soil specimen being predominantly shear in nature, the UCS value can be regarded as an indirect measure of strength. The values obtained from UCS tests for soil with strip contents ranged from 0% to 6% for different aspect ratios (AR=1 to 5) are shown in Figure through Figure. It can be observed from these figures that mixing of randomly HDPE strips in soil increased the load. The figures further reveals that the initial slope of the line of UCS value is significantly improved due to the incorporation of strips in soil. The aspect ratio, it is deduced that so long as the strips are short, smaller friction is developed at the ends of the strips. With increase in aspect ratio/length, the friction and in turn the tensile strength increases up to certain limit. Higher aspect ratio or longer lengths will make strip surfaces slippery resulting in lower values of CBR and strength of the soil.

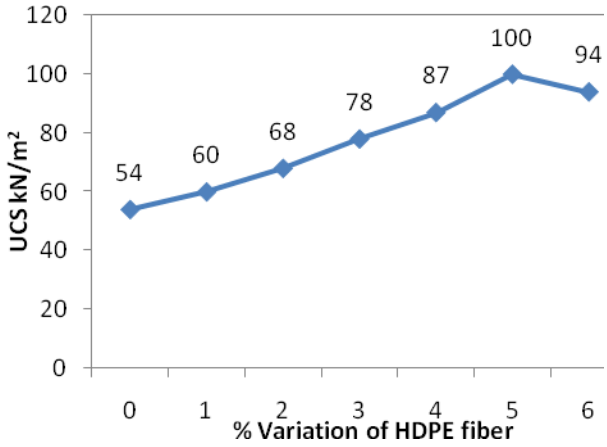

Fig. 1 Variation of UCS value of mixture of black cotton soil and AR 1 HDPE strips

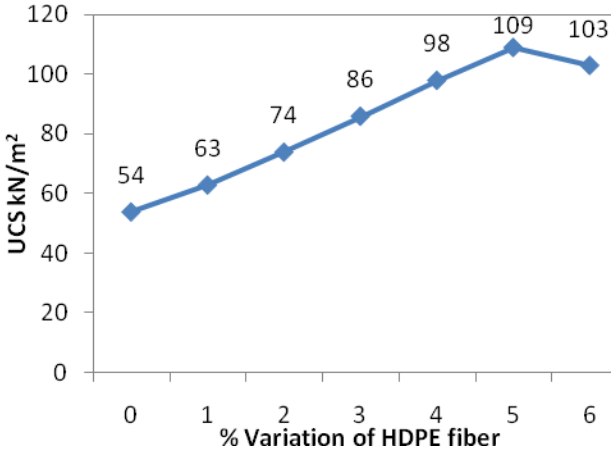

Fig. 2 Variation of UCS value of mixture of black cotton soil and AR 2 HDPE strips

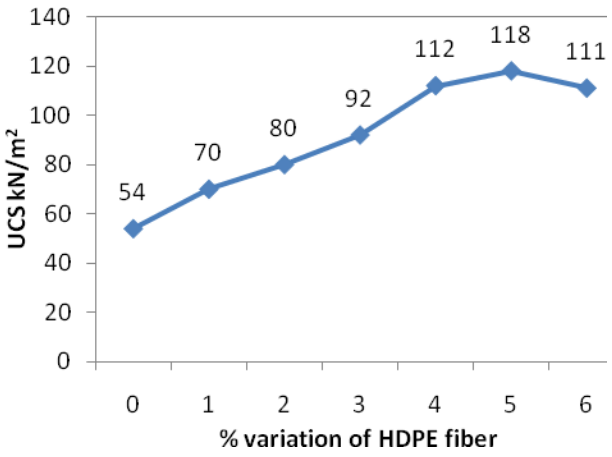

Fig. 3 Variation of UCS value of mixture of black cotton soil and AR 3 HDPE strips

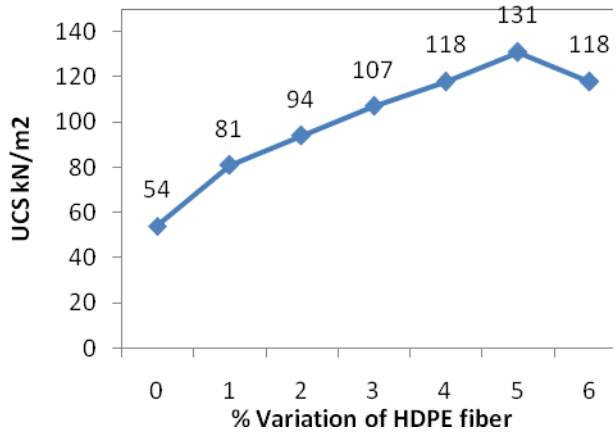

Fig 4 Variation of UCS value of mixture of black cotton soil and AR 4 HDPE strips

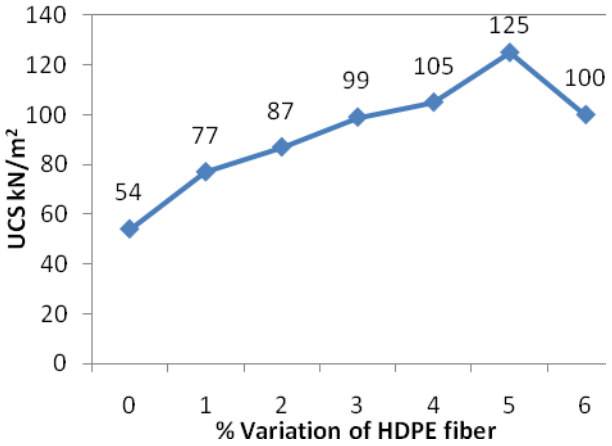

Fig 5 Variation of UCS value of black mixture of black cotton soil and AR 5 HDPE strips.

After that addition of 6% HDPE fiber strength decreased as compared to peak value of UCS. It can be observed from the graph that UCS value increases as the percentage of HDPE was increased up to 5%. After increase in HDPE percentage results in decrease of UCS value. Such behaviour of reinforced soil was probably exhibited because of the size of mould, slippery reaction, less space for placing of HDPE strips.

VI. CONCLUSION

The feasibility of soil reinforcement with HDPE by variation of percentage and aspect ratio of strips may be concluded from the study that –

- With increasing percentage of additives shows more favourable results are obtained thereby enhancing the properties of black cotton soil.
- After addition of HDPE fibre strips in black cotton soil MDD of treated black cotton soil increases and OMC of treated black cotton soil decreases.
- AR 4 (up to 5%) addition of HDPE strips to black cotton soil mixture attains its highest value of unconfined compression strength.
- The optimum fibre content corresponding to maximum improvement in CBR value and UCS was found to be AR 4 of 5%.
- From this study an environmental friendly technology is introduced which can benefit the society and nation, through which the impact of solid waste on environment is reduced and material can recycle in proper manner.

VII. APPENDIX

AR – Aspect Ratio, BCS – Black Cotton Soil HDPE – High Density Polyethylene

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