EFFECT OF HDPE STRIPS & GYPSUM ON THE CBR VALUE OF FINE-GRAINED SOIL

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Abstract : Plastic is considered as the one of the biggest invention of the era. Being lightweight, non-toxic and easy to handle & transport found various applications in the todays world and widely used everywhere. With the heavy rise in the populations, the need of plastic also increases which consequently also leads to rise in the plastic waste. Plastic are derivative of hydrocarbon, HDPE being one of them, mainly are non-biodegradable therefore causes the problem to where to dump the waste. So the principle of recycling now playing a major role for tackling this situation.
In this investigation, standard proctor test and in addition CBR test are performed to check how the fine-grained soil behaves with the addition of various proportions of HDPE strips along with the chemical gypsum. Experiments are done for various proportions and then compared with the parent soil. Positive results are shown with addition of gypsum and HDPE strips. There is a rise in the value of CBR with the increasing proportion of gypsum and in case of HDPE strips, the value rises till 0.75% thereafter the CBR value declines.
From this examination it is determined that accumulation of HDPE strips and gypsum improves the strength of weak fine-grained soil and a cost-effective pavement can be made. Also, it reduces the problem of dumping plastics to some extent hence decreasing load on waste management.

IndexTerms **–CBR, Fine grained soil, HDPE Strips, Plastic, Soil Stabilisation.**

I. INTRODUCTION

For any structure, soil plays the significant role because the foundation has to be rested on the soil. So the soil should have such properties to tolerate the load of the foundation. But sometimes soil is unable to withstand the conditions. So in this scenario, the procedure of soil stabilisation is required so that soil can acquire the properties which are required for that condition. Waste management is still a challenge for today's world. Plastic is widely used nowadays. With the increasing population, the use of plastic is also increasing at higher rate because every sector uses plastic. With this, the plastic waste is also increasing. The production of plastic is very high in India. Being the non-biodegradable matter, it pollutes our environment and there is serious problem of disposing plastics. So now it becomes an environmental hazard. To control this, state governments are now imposing ban on the use of Plastic as carry bags but still the problem persists. Plastic can be used again and again for several purposes. Therefore, different ways of reusing it are finding out and one of them is using it for the stabilisation of soil. Plastic being one of the easily available and also cheaply as in the form of waste can be used to enhance the property of the soil.

II. LITERATURE REVIEW

Kumar , et al. (2018) showed experiment on behaviour of soil mixing with plastic strips (LDPE). The tests were directed at several strip contents of 0%, 0.2%, 0.5% , 0.8% and 1.0% of the dry weight of soil. With the rise of plastic contents, the value of MDD decreases whereas the value of OMC increases. There is a surge in the CBR value for soil with the growth in fraction of plastic strips. The maximum CBR value obtained when plastic strips are of 2 cm long and are added with 0.8% of the dry weight of soil.

Sikarwar and Trivedi (2017) investigated the effect of gypsum on clay soil with the percentages of 2% 4% 6% & 8% and the sample which give best result is further treated with 1% calcium chloride. From the results, it was concluded with increasing extent of gypsum OMC decreases from 18.66% to 12.9% whereas MDD increase till 4% then decrease for 6% gypsum and then again increases at 8 % gypsum. CBR value of soil rises from 2.73% to 7.57% till 4% addition and then drops to 6.3% for 8% gypsum. Further study is carried with soil with 4% gypsum is blended with 1 % of calcium chloride. OMC & MDD of sample is 11.49 % 19.24 kN/m3 respectively whereas CBR Value rises from 7.57% to 8.94%.

Rawat and Kumar (2016) conducted experiments on the use of HDPE strips reinforced in a CL-ML soil. The HDPE sheets were firstly cut into strips of width 5mm and then three aspect ratios were taken as 1, 2 and 3. Strips had to be randomly mixed in the soil in proportions (0.5%, 1.0%, 1.5% and 2%) by weight of dry soil. The results obtained on compaction characteristics and CBR value of the soil. A decrease in the dry density of soil with increase in aspect ratio and HDPE content dry density decrease whereas CBR value is observed to rise up with increase the aspect ratio. CBR value was maximum at 1.5% and further at 2% it decreases. CBR value of optimised soil sample is 4 times than that of untreated soil.

Varghese, et al. (2016) performed tests using Plastic Fibers that are used for milk and curd packets. Compaction test and UCS test were conducted. Experiments conducted by varying waste plastic content in the range of 0%, 0.25%, 0.5%, 1.0% and 1.5 %. Results shows MDD and UCS increases from 0.0255 N/mm2 for virgin sample to 0.050 N/mm2 for soil treated with 0.5% plastic and with further increase in fibres it decreases. The OMC is minimum at 0.5% and then increases.

Dhatrak and Konmare (2016) performed compaction tests and also calculated the CBR Value by mixing waste plastic bottle as strips/chips. The proportion taken was 0.5%, 1%, 1.5%, 2% and 2.5% of the weight of dry soil. Test results indicate that the MDD decreases with the increase in the plastic content, because of lower density of plastic strips than that of the soil particles. Soaked CBR values are increased by 40%. Maximum soaked CBR value is 3% when percentage of plastic strip content is 2%..

Jacob and Vivek R (2015) compared the effect of addition of HDPE strips with the HDPE fibres on compaction properties, UCC Test and CBR test. The size of strips they used was of 5mm wide and varyiong length of 2, 4 and 6 cm whereas the fibres used has a diameter of about 1mm is mixed with soil in the ratio of about 0 ,1, 2, 3 and 4 by weight. At the point when soil is

strengthened with HDPE strips and fibers, an increment in dry density of about 22% on account of HDPE strips and 8.7% on account of HDPE fibres were observed. CBR of soil strengthened with HDPE strips was seen to have an addition of about 4.62 times and about 4.03 times on account of HDPE fibres when thought about to soil with no HDPE. UCC value was likewise found to have an increase 1.85 times when HDPE strips were included also, 0.28 times increase was recorded for HDPE fiber addition to clayey soil.

Pillai, et al. (2015) did Compaction test and CBR to determine the maximum dry density, optimum moisture content and CBR values of the soil sample. Experiments were conducted on waste plastic content 0%, 0.25%, 0.5%, 1.0%, and 1.5 % and quarry dust by 0%, 10%, 20%, 30%, 40% and 50%. Results shows that dry density increases and optimum moisture content decreases with 0.25% HDPE granules and after that MDD decreases and OMC increases. And for quarry dust, the maximum dry density increases and optimum moisture content decreases upto 40 % and with further increase the maximum dry density decreases and optimum moisture content increases. Furthermore, increase in quarry dust reduces maximum dry density & optimum moisture content on decreasing. CBR value increased at 0.25% HDPE content and with further addition of HDPE granules the CBR value decreases. An increase in CBR value is seen up to a quarry dust content of 40% and further increase in quarry dust content reduces the CBR value.

III. OBJECTIVES OF THE STUDY

- To study the effect on the compaction characteristics of soil using HDPE strips and Gypsum as additive.
- To study the effect on CBR value of fine grained soil by mixing additives at various percentages.
- To provide an alternative solution for the disposal of plastic waste.
- To provide an economical solution for soil stabilization using plastic waste.

IV. MATERIAL & RESEARCH METHODOLOGY

4.1 *Problem Formulation*

According to report by CPCB, 25940 tonnes of plastic waste is generated by India everyday in which 40% of it is not collected which create problems in drainage choking, pollution in air water leads to bad effect on humans. Taking note of the hazard of uncollected plastic waste, India had a year ago deliberately dedicated to taking out, at any rate, single utilize plastic by 2022. So, amount of plastic waste in India is increasing at very big rate & HDPE is one of the main contributors of plastic waste. So, mitigation measures should be taken so that we will dispose this waste in a effective way to enhancing the properties of soil. Many methods are employed to utilise the plastic waste because disposing into landfill is also not a good option as these are not biodegradable in nature. Taken this into consideration, a study here is presented here to concentrate on soil stabilization by waste plastic along with chemical.

3.2 *Research Methodology*

Firstly, the properties like Atterberg limits and specific gravity of soil was found out by performing Casagrande apparatus Test, Thread test and Pycnometer test respectively. Then gypsum was added as the percentage of 2%, 4% & 6%, the percentage giving effective result is selected as optimised value of gypsum which was selected as 4% for standard proctor test. Then the mix proportions were made by adding HDPE strips in the percentage of 0.5%, 0.75% & 1% by the weight of dry soil and gypsum in the percentage of 4%. Then the standard proctor test was done to find out maximum dry density and optimum moisture content of each sample. In case of CBR, the mixtures with 6% gypsum gives maximum improvement in CBR values. The values obtained from standard proctor experiment were taken and then used for finding CBR value of each sample.

3.3 *Materials Used*

3.3.1 Soil

The fine-grained soil i.e. used in this investigation was collected from Village Boparai Khurd in Ludhiana district.

3.3.2 HDPE Strips

Strips were collected from factory located in Ludhiana, a factory that produce carry bags for the clothes. The HDPE strips are transparent. The high density polyethylene (HDPE) available was available in size of 5mm wide and length of 24mm.

3.3.3 Gypsum

Gypsum chemical formula is $CaSO_4.2H_2O$. Gypsum packets are purchased from local markets in Ludhiana. Gypsum comes in the category of sulphates. Gypsum chemical formula is Hydrated Calcium Sulphate or Calcium Sulphate Dihydrate. Gypsum is white in colour. Gypsum has wide applications.

IV. RESULTS AND DISCUSSION

4.1 *Properties of Soil Sample*

Table 1 Properties of Soil Sample

S.No.	Properties	Value
1.	**Atterberg Limits**	
	a) Liquid Limit, LL	45
	b) Plastic Limit, PL	21
	c) Plasticity Index, PI	24
2	Soil Classification	CI
3	Specific Gravity	2.45
4	**Standard Proctor Test Properties**	
	a) Maximum Dry Density, MDD	17.62 kN/m^3
	b) Optimum Moisture Content, OMC	16.2 %
5	Soaked California Bearing Ratio Test, CBR	2.6 %

4.2 *Standard Proctor Test Results*

Table 2 Test Results of Soil Sample with percentage of Gypsum

Sample	MDD (kN/m^3)	OMC (%)
Virgin Soil	17.62	16.2
Soil with 2% gypsum	18.59	16
Soil with 4% gypsum	18.87	15.6
Soil with 6% gypsum	18.31	15.9

MDD: Maximum Dry Density; **OMC**: Optimum Moisture Content

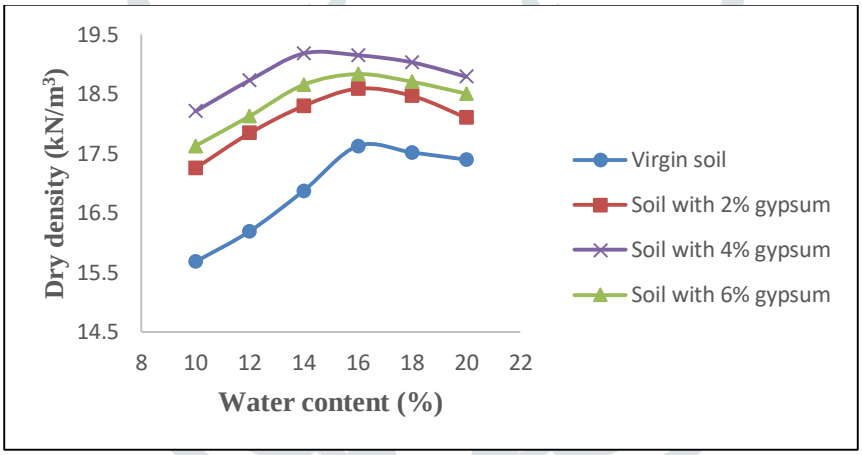

Figure 1 Compaction Curves for Soil mix with Gypsum

Table 3 Test Results of Soil Sample with percentage of HDPE Strips

Sample	MDD (kN/m^3)	OMC (%)
Virgin Soil	17.62	16.2
Soil with 0.50% HDPE Strips	15.95	16.4
Soil with 0.75% HDPE Strips	15.12	17
Soil with 1.0% HDPE Strips	14.65	17.2

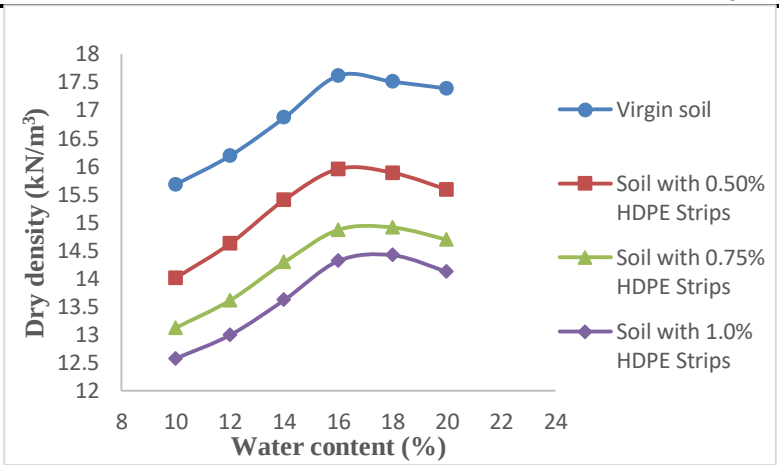

Figure 2 Compaction Curves for Soil mix with HDPE Strips

Table 4 Test Results of Soil Sample with percentage of HDPE Strips with 4% Gypsum

Sample	MDD (kN/m^3)	OMC (%)
Virgin Soil	17.62	16.2
Soil with 0.50% HDPE Strips & 4% Gypsum	18.49	16.5
Soil with 0.75% HDPE Strips & 4% Gypsum	19.47	18
Soil with 1.0% HDPE Strips & 4% Gypsum	19.25	18.2

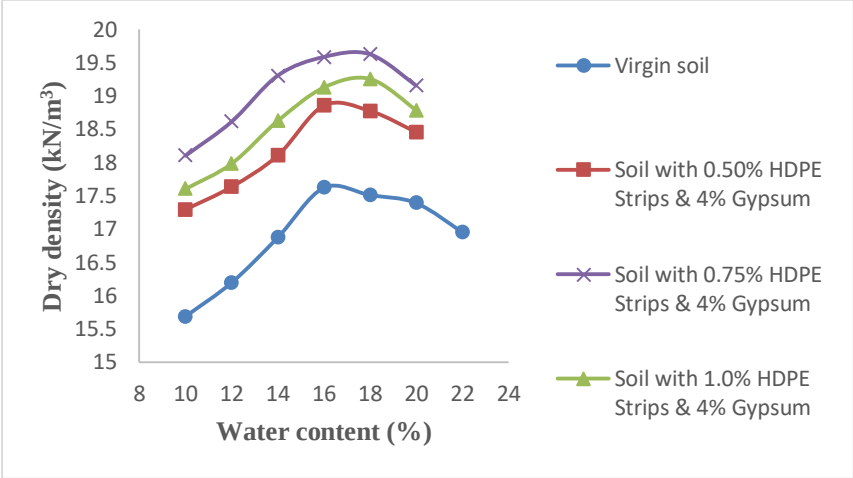

Figure 3 Compaction Curves for Soil mix with HDPE Strips & 4% Gypsum

4.3 *CBR Test Results*

Table 5 Test Results of Soil Sample with percentage of HDPE Strips with 6% Gypsum

Sample	CBR (%)
Virgin Soil	2.6
Soil with 0.50% HDPE Strips & 6% Gypsum	7.7
Soil with 0.75% HDPE Strips & 6% Gypsum	10.0
Soil with 1.0% HDPE Strips & 6% Gypsum	8.6

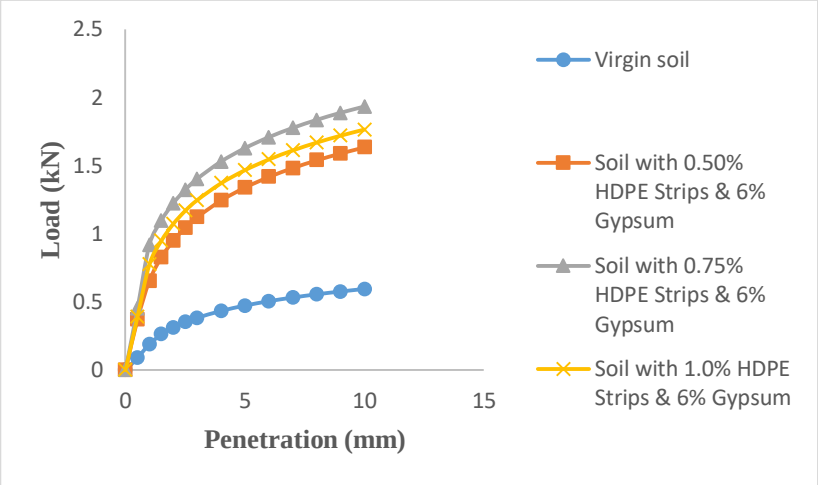

Figure 4 Load Penetration Curves for Soil mix with HDPE Strips & 6% Gypsum

V. CONCLUSION

- Findings shows that HDPE strips reinforced gypsum mixed soil can be used an application for improving the soil for the foundation or for the road construction pavement.
- Reinforcing soil with HDPE strips and gypsum it increases the OMC and MDD. If we only add HDPE strips in the soil it decreases the density of the soil so can't be alone used at the project which needs high density composite but thanks to gypsum creating a stable mix of high density.
- This study gives the alternative way to dispose the waste HDPE. Rather than throwing into the landfills it has applications in civil engineering field. The disposal method is cost effective also as it decreases the thickness lead to economic design. Thus, solving a problem for waste management also.
- The CBR goes from 2.6% to 10.0% which subsequently leads to reduce the thickness of layers and the project becomes cost effective.

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