SOIL STABILITY INVESTIGATION WITH POLYETHYLENE (LDPE) USING LIME

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Abstract - *The amount of waste polyethylene fibre materials is rapidly increasing; these wastes Because polyethylene fibres are non biodegradable fibre materials, they are commonly dumped or thrown, endangering the ecology and ecosystem. Polyethylene fibre materials are one of the waste fibre materials among these. Polyethylene fibre (Milk packets strips - LDPE) was employed as an element in this study to improve the qualities of natural soil. Polyethylene fibre has been used to replace soil in a given percentage, and tests have been conducted. To determine the optimal amount of polyethylene fibre, the soil was replaced with varied quantities of polyethylene fibre.Based on the findings of the experiments, it was discovered that replacing various soil qualities with 1.0 percent polyethylene fibre by weight of soil produces the best results. Unconfined Compressive Strength has increased from 3.24 kg/cm2 to 7.40 kg/cm2, indicating that it can now withstand higher loads. MDD has also grown in value from 1.71 g/cm3 to 1.78 g/cm3, equal to 1% polyethylene fibre. However, due to the low density of polyethylene fibre, the percentage of increase is minimal. In addition, the value of Soaked CBR rises from 1.92 to 3.44, corresponding to 1% polyethylene fibre. Which shows that it can be utilised for pavement in locations with a high ground water table. And at 1% polyethylene fibre, the value of Unsoaked CBR increases from 4.09 to 6.41, indicating that we can reduce pavement thickness in pavement design, lowering construction costs in highway and railway construction.*

Key Words: Polyethylene fiber, soil, Sodium hydroxide, maximum dry density, optimum moisture content, unconfined compressive strength, CBR

1.INTRODUCTION

1.1 General

Clayey soil covers a considerable chunk of our country's entire land area. A major amount of this is pricey dirt. Minerals capable of absorbing water, such as montmorillonite, can be found in these soils. Their volume grows as they absorb water. Because of its extreme swell-shrinkage behaviour, structures built on this pricey soil may be badly harmed. As a result, such soils must be stabilised in order to increase their strength, durability, and resistance to erosion. Various studies on clayey soil have been conducted in order to improve its qualities.

1.2 Soil Stablisation

Soil stabilisation is the process of altering soil parameters in order to improve soil strength and durability. Soil stabilisation can be accomplished by a variety of methods, including compaction, dewatering, and the addition of reinforcing materials such as lime treated polyethylene to the soil. Before constructing any form of construction, we must first ensure that the soil is stable. As we all know, any structure's load is carried to the earth and dispersed among the soil particles.

2. EXPERIMENTAL SETUP

2.1 GENERAL

The qualities of natural soil have been determined through a series of laboratory investigations. The appropriate additive requirements have also been obtained. Various tests have been carried out in order to investigate the changing properties of stabilised soil. Grain size distribution test, Atterberg's limit test, Proctor compaction test, Unconfined Compressive Strength test, and CBR test are some of the tests available.

2.2 MATERIALS USED

2.1 Soil :-

The soil sample for this investigation was acquired by open excavation from the bank of the Swarnrekha river in Singh more, Ranchi, to a depth of 1.0-1.5 metres below the natural ground surface, as indicated in fig 3.1. To conduct the numerous experiments, the dirt was pulverised and dried.

2.2 Lime :-

Lime is a byproduct of limestone combustion. Lime-based soil stabilisation is widely employed in a variety of building projects, including foundations, highways, railways, airports, embankments, slope protection, canal lining, and so on. Because lime is inexpensive and easily available, it is often utilised for soil stabilisation. Lime is employed as a binding ingredient in this study, as well as for treating polyethylene to make the surface rougher, improving the bonding between polyethylene and soil to some extent. When lime is put to the soil, it absorbs porewater for hydration and increases the amount of water needed for soil stabilisation.

2.3 Low density Polyethylene :-

Waste milk packets are collected from Sindri Tea stalls. These wastes are the type of LDPE (low density polyethylene). The collected milk packets are cut into strips with length of approx. 10mm, and width of 5 mm,

Fig 2.1 : Lime treated polyethylene strips

2.3 METHODOLOGY

2.3.1 Specific Gravity -The mass of a certain volume of sample divided by the mass of an identical amount of water at the same temperature is the specific gravity of soil. On clayey soil, the specific gravity test was performed according to the procedure outlined in IS: 2720 Part 3 -section 1- 1980. The specific gravity test was done with a pycnometer bottle.

Fig 2.2 : Pycnometer

2.3.2 Grain size distribution- The grain size analysis is done in accordance with IS:2720 part 4-1985. The percentage of the total weight of soil flowing through each sieve can be estimated using the total weight of dirt obtained and the weight of soil retained on each sieve that conforms to the IS standard.

2.3.3 Atterberg's Limit Tests :

Liquid limit-It's the water content at which a soil is almost liquid but has minuscule resistance to flow, as measured by any conventional liquid limit equipment. The liquid limit test was performed on clayey soil according to the procedure outlined in IS:2720 Part 5-1985. The liquid limit test was performed using the Casagrande apparatus.

Fig 2.3 : Liquid limit apparatus

Plastic limit- When rolled into a thread of around 3mm diameter, it is described as the water content at which a soil begins to collapse. This test was performed on clayey soil according to the instructions in IS:2720 Part 5-1985..

2.3.4 Maximum dry density & optimum moisture content

The optimum moisture content is the water content that corresponds to the highest dry unit weight (OMC). The standards for field compaction of fillings are normally based on MDD, but they can also be based on both MDD and OMC. The OMC and MDD tests were performed on clayey soil according to the procedure outlined in IS: 2720, Part 7-1974. The standard proctor test or light compaction test is another name for this test.

2.3.5 Unconfined Compressive Strength test

This is a type of triaxial test that is performed at zero cell pressure. This is a fast or undrained test that is frequently used to measure the in situ strength of soft, saturated fine-grained soil layers. The test was conducted on clayey soil according to the procedure outlined in IS: 2720 Part 10-1991.

2.3.6 California Bearing Ratio test

CBR is a penetration test that is used to determine the mechanical strength of natural ground, subgrades, and base courses beneath a new carriageway. CBR values are typically calculated at 2.5 and 5.0 mm penetration. The CBR value is determined using the corrected load value from the load penetration curve, which corresponds to the penetration value at which the CBR value is wanted. The CBR test was performed according to the procedure outlined in IS: 2720 Part 16-1987.

2.4 Properties of soil :

S. No.	Parameters	Values
1.	Specific Gravity	2.59
2.	Liquid limit	39.20%
3.	Plastic limit	21.90%

4.	Plasticity index	17.30%
5.	OMC	15.93%
6.	MDD	1.710 g/cc
7.	UCS	3.24 kg/cm^2
8.	Soaked CBR	1.93%
9.	Un-soaked CBR	4.09%
10.	Percentage finer than 75 micron (clay + silt)	58.8 %
11.	Percentage of clay	15.32%

2.5 Dosing and mixing

Different % of polyethylene fiber i.e..0.25%,0.50%,0.75%,1.0% and 1.25% of polyethylene fiber by weight of soil are used .Treated polyethylene fiber are then mixed with soil by hand properly to get uniform mix and add water as per requirement.

2.6 Preparation of soil sample

For experimental study different samples have been prepared with different proportions of lime treated polyethylene fiber, which have been given in the table below

Sample	Soil(%)	Lime treated Polyethylene strips(%)
1	100	0
2	99.75	0.25
3	99.5	0.50
4	99.25	0.75
5	99	1
6	98.75	1.25

3. RESULTS AND DISCUSSIONS

3.1 Atterberg's limit test results

Liquid limit and plastic limit test

The result obtained from the Aterberg's limit test on soil with different percentage of lime treated polyethylene has given in table

Table 3.1 - Liquid limit and plastic limit test results

Sample notation	Soil %	%lime treated polyethylene	WL%	WP%
S1	100	0	39.20	21.90
S2	99.75	0.25	39.12	22.04
S3	99.50	0.50	39.04	22.13
S4	99.25	0.75	38.86	22.47
S5	99.0	1.0	38.73	22.89
S6	98.75	1.25	38.54	23.14

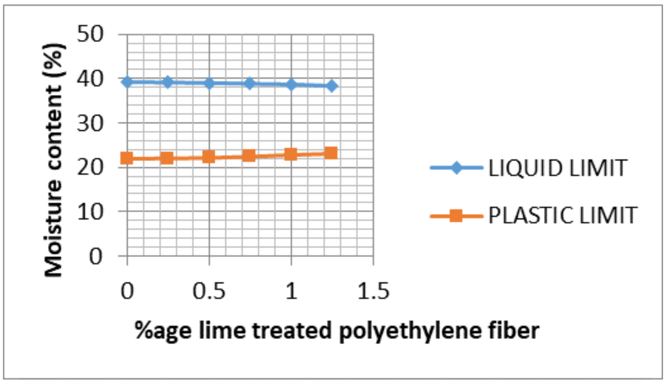

Fig 3.1 : Atterberg's limit with different %ages of lime treated polyethylene fibers

3.2 Proctor test results

Table shows the variations of maximum dry density with the variation of lime treated polyethylene fibers

Table 3.2- Values of MDD & OMC Test results

S.N.	Soil (%)	Lime treated polyethylene (%)	MDD (g/cc)	OMC (%)
1.	100.00	0	1.71	15.93
2.	99.75	0.25	1.72	15.65
3.	99.50	0.50	1.74	15.42
4.	99.25	0.75	1.75	15.08
5.	99.0	1.0	1.78	14.82
6.	98.75	1.25	1.74	15.43
7	98.5	1.50	1.72	15.76

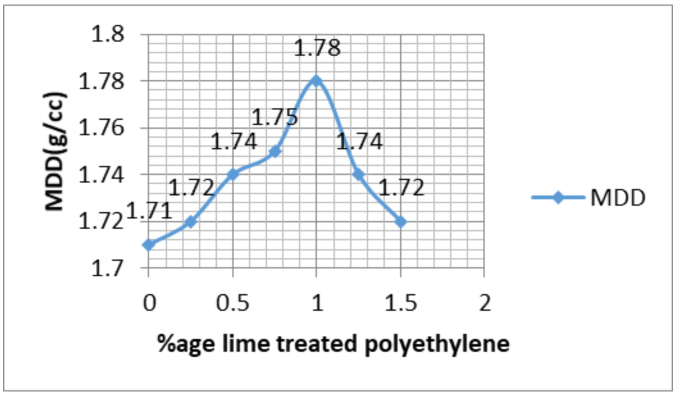

Fig 3.2 : Variation of MDD with %age lime treated polyethylene fibers

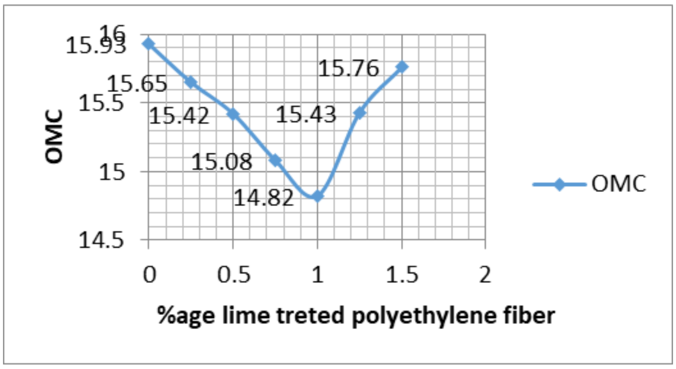

Fig 3.3 : Variation of OMC with %age lime treated polyethylene fibers

3.3 Unconfined compressive strength test result

Values of UCS of the soil sample mixed with different percentage of polyethylene fiber and its variation with natural soil have been tabulated below :

Table 3.3 – UCS test result

S.No.	Soil (%)	%age limit treated polyethylene fiber	UCS(kg/cm^2)
1.	100.0	0	3.24
2.	99.75	0.25	3.57
3.	99.50	0.50	5.12
4.	99.25	0.75	6.20
5.	99.0	1.0	7.40
6.	98.75	1.25	5.26
7.	98.5	1.50	4.38

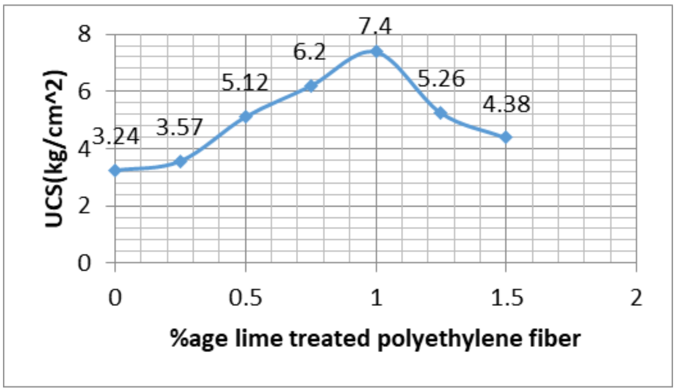

Fig 3.4 : Variation of UCS with %age lime treated polyethylene fiber

3.4 CBR test results

Unsoaked CBR

CBR value of the soil samples mixed with different percentage of polyethylene fiber in unsoaked condition and its variation with natural soil have been tabulated below

Table 3.4 – Unsoaked CBR Test results

S.N.	Soil %	% lime treated Polyethylene fiber	Unsoaked CBR %
1	100.0	0	4.09
2	99.75	0.25	4.56
3	99.50	0.50	5.12
4	99.25	0.75	5.44
5	99.0	1.0	6.41
6	98.75	1.25	5.69
7	98.50	1.50	5.20

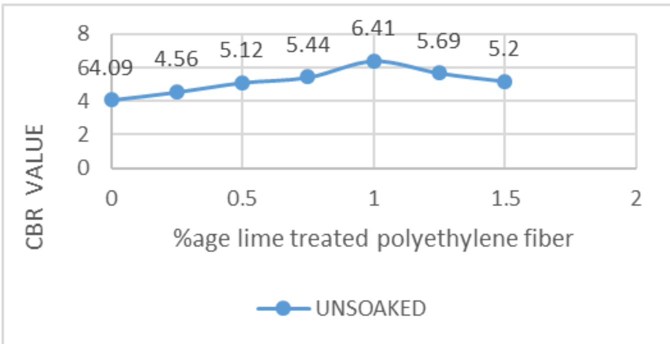

Fig 3.5 - Variation of Unsoaked CBR with %age lime treated polyethylene fiber

Soaked CBR

CBR values of the soil samples mixed with different percentage of lime treated polyethylene fiber in soaked condition and its variation with natural soil have been tabulated below:

Table 3.5 – Soaked CBR test results

S.N.	Soil(%)	%lime treated polyethylene fiber	Soaked CBR(%)
1	100	0	1.92
2	99.75	0.25	2.23
3	99.50	0.50	2.63
4	99.25	0.75	2.88
5	99.00	1.0	3.44
6	98.75	1.25	2.80
7	98.50	1.50	2.54

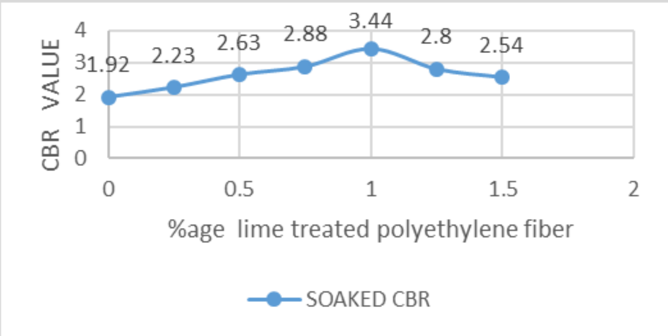

Fig 3.6 - Variation of Soaked CBR with %age lime treated polyethylene fiber

Comparison between Soaked CBR and Unsoaked CBR

Table 3.6 - Comparison between Soaked CBR and Unsoaked CBR

S.N.	Soil(%)	% lime treated polyethylene fiber	Soaked CBR (%)	Unsoaked CBR(%)
1	100	0	1.92	4.09
2	99.75	0.25	2.23	4.56
3	99.50	0.50	2.63	5.12
4	99.25	0.75	2.88	5.44
5	99.00	1.0	3.44	6.41
6	98.75	1.25	2.80	5.69
7	98.50	1.50	2.54	5.20

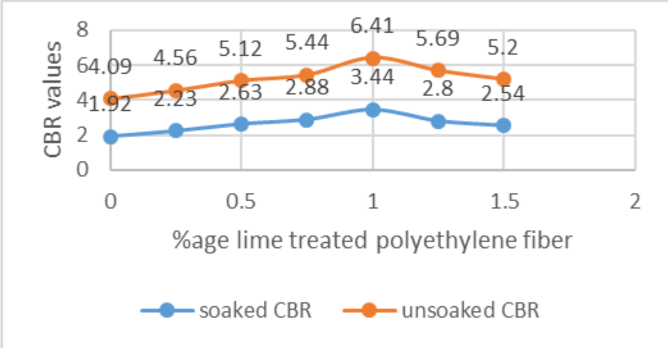

Fig 3.7 - Comparison of Soaked and Unsoaked CBR

4. CONCLUSIONS

From the experimental results , it has been found the various properties of soil replaced with 1.0% of lime treated polyethylene fiber by weight of soil gives optimum results .

1. The UCS value has grown from 3.24 kg/cm2 to 7.40 kg/cm2, equating to 1.0 percent lime treated polyethylene fibre, a 128.39 percent increase, indicating that it can support heavier loads..
2. The MDD value has also been enhanced from 1.71 g/cm3 to 1.78 g/cm3, equal to 1.0 %age lime treated polyethylene fibre, although due to the low density of polyethylene fibre, the percentage of increase is minimal.
3. Soaked CBR's value rises from 1.92 percent to 3.44 percent, equating to 1.0 %age lime treated polyethylene fibre, indicating that it can be utilised for pavement in places with a high ground water table.
4. At 1.0 %age lime treated polyethylene fibre, the value of Unsoaked CBR increases from 4.09 to 6.41 percent, indicating that we can reduce pavement thickness for pavement design. We can increase the slope of the pavement to lower the cost of construction in highways and railways, as well as for slope stability..

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