EasyChair Preprint

№ 3100

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April 2, 2020

COMBINED EFFECT OF LIME FLYASH AND GEOSYNTHETIC REINFORCEMENT ON SOIL

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Abstract Soft soil possesses low strength and undergoes excessive volume changes, making its use in the construction activities very difficult. The properties of the soft soils may be altered in many ways viz, mechanical, thermal, chemical and other means. Modification of soft soils by chemical admixtures is a common stabilisation method for such soils. Soil reinforcement is another one of the most popular ground improvement techniques, especially for granular soils. Geotextile and Geomembrane reinforcement are suitable soil reinforcement techniques. In this investigation, traditional stabilising agents such as cement, lime, fly ash etc. are applied in addition to geotextile and geomembrane reinforcement. This project is an attempt to study the combined effect of geotextile and geomembrane reinforcement as well as traditional stabilizing agents in soil improvement.

Keywords: Geotextile, geomembrane, stabilization,

INTRODUCTION

Soft soil possesses low strength and undergoes excessive volume changes, making its use in the construction activities very difficult. The properties of the soft soils may be altered in many ways viz, mechanical, thermal, chemical and other means. Modification of soft soils by chemical admixtures is a common stabilisation method for such soils. Among various admixtures available, lime, fly ash and cement are most widely and commonly used for the stabilisation of soft soils. Fly ash contains siliceous and aluminous materials (pozzolans) and also certain amount of lime. When mixed with soft soil, it reacts chemically and forms cementitious compounds. The presence of free lime and inert particles in fly ash suggests that it can be used for stabilisation of expansive soils. Lime stabilisation is a method of chemically transforming unstable soils into structurally sound construction foundations. Lime is added to a reactive soil to generate long-term strength gain through a pozzolanic reaction. Lime treatment can produce high and long-lasting strength. In a developing country like India, due to industrial development there is

an increase in a demand for energy which has resulted in construction of considerable coal-burning power plants. This development brought with the problem of safe disposal or beneficial utilisation of large quantities of by-products like fly ash every year and there is a signal requirement to be carried out towards management of fly ash disposal and utilisation.

OBJECTIVES

- To evaluate the index and engineering properties of Kuttanad clay.
- To determine the optimum proportion of stabilising agents such as flyash (1.25,2.5 and 3.75%) and lime (4%,6% and 8%)by weight of soil
- To study the combined effect of geotextile, geomembrane and traditional stabilising agents in soil improvement.
- To determine the variation in strength characteristics and optimum number of reinforcing layers (geotextile placed at h/2 and h/3) on combining geotextile and optimum percentage of stabilizing agents with soil

METHODOLOGY

- Procurement of soil sample and collection of stabilising agents, Geotextile and geomembrane.
- Determination of physical properties of soil (Kuttanad clay).
- Determination of shear strength and subgrade strength of untreated, unreinforced soil.
- Determination of shear strength and subgrade strength of soil with lime/ flyash stabilisation.
- Determination of shear strength and subgrade strength of soil with lime/ flyash treatment and geotextile reinforcement.
- Interpretation of the experimental result

EXPERIMENTAL STUDY

- Stabilising agents (lime, flyash) were added to the calculated quantity of soil at different percentages such as 5%, 8% and 12%.
- All the soil samples were compacted at their respective optimum moisture content (OMC).
- The specimens were kept for curing for 7 days.
- After the curing period UCS and CBR tests were carried out for soil-lime and soil-flyash specimens.
- In reinforced specimens, geotextile/geomembrane was placed at half the depth (h/2) or at one third of the depth (h/3).

The following sections describe the observations and results of the properties of soil sample.

PROPERTIES	VALUES
Average moisture content of the soil sample, w	21.494 %
Liquid limit of the sample	74%
Plastic limit of soil, WP	52.1 %
Plasticity index	21.9%
Specific gravity of the sample	2.69
Unconfined compressive strength, qu	48.35 kN/m^2
Cohesion ,c	24 kN/m^2

STABILISATION OF SOIL (UNREINFORCED)

The percentage improvement in strength due to treatment of soil with lime and flyash in unreinforced state is analysed with reference to untreated-unreinforced state.

Soil-Lime Stabilisation

Table 1 soil- lime stabilisation

Stabilising agent	Percentage of replacement	Denoted by	Unconfined compressive strength (kN/m2)	Cohesion (kN/m2)	Percentage of improvement
Lime	5	SL5	93.1	47.2	92.55
	8	SL8	134.8	67.4	178.8
	12	SL12	161.3	80.65	233.6

Soil-Flyash Stabilisation

Table 2 Soil – Flyash stabilisation

Stabilising agent	Percentage of replacement	Denoted by	Unconfined compressive strength (kN/m^2)	Cohesion (kN/m^2)	Percentage of improvement
Fly ash	5	SF_5	171.1	85.5	253.87
	8	SF_8	167.6	83.8	246.63
	12	SF_{12}	153.2	76.6	216.85

Soil-Lime-Flyash Stabilisation

Table 3 Soil-Lime-Flyash Stabilisation

Stabilising agent	Percentage of Replacement	Denoted by	Unconfined Compressive strength (kN/m^2)	Cohesion (kN/m^2)	Percentage of improvement
Lime and fly ash	Lime-8%, fly ash-1.25%	$SL_8F_{1.25}$	178.89	89.4	269.98
	Lime-6%, fly ash-2.5%	$SL_6F_{2.5}$	152	76	214.37
	Lime-8%, fly ash-3.75%	$SL_8F_{3.75}$	292.3	146.15	504.55

STABILISATION OF SOIL – GEOTEXTILE (REINFORCED)

The percentage improvement in strength due to treatment of soil with lime, flyash and geotextile in reinforced state is analysed with reference to untreated-unreinforced state.

Soil-Lime Stabilisation with Geotextile

Table 4 Soil-Lime Stabilisation with Geotextile

Stabilising agent	Percentage of replacement	Position of geotextile	Unconfined compressive strength (kN/m^2)	Cohesion (kN/m^2)	Percentage of improvement
Lime	5	h/2	233.2	116.6	382.31
		h/3	303.72	151.86	528.16
Lime	8	h/2	214.41	107.20	343.45
		h/3	329.28	164.64	581.03
Lime	12	h/2	247.47	123.73	411.83
		h/3	477.84	238.92	888.29

Soil-Flyash Stabilisation with Geotextile

Table 5 Soil-Flyash Stabilisation with Geotextile**.**

Stabilising agent	Percentage of replacement	Position of geotextile	Unconfined compressive strength (kN/m^2)	Cohesion (kN/m^2)	Percentage of improvement
Flyash	5	h/2	115.5	57.75	138.88
		h/3	185.0	92.5	282.62
Flyash	8	h/2	142.31	71.15	194.33

		h/3	219.08	109.54	353.11
Flyash	12	h/2	154.69	77.34	219.93
		h/3	254.71	127.35	426.80

Soil-Lime-Flyash Stabilisation with Geotextile

Table 6 Soil-Lime-Flyash Stabilisation with Geotextile

Stabilising agent	Percentage of replacement	Position of geotextile	Unconfined compressive strength (kN/m^2)	Cohesion (kN/m^2)	Percentage of improvement
Lime and fly ash	Lime-8%, fly ash-1.25%	h/2	314.2	157.1	549.84
		h/3	339.05	169.52	601.24
	Lime-6%, fly ash-2.5%	h/2	191.34	95.67	295.73
		h/3	237.42	118.71	391.04
	Lime-8%, fly ash-3.75%	h/2	197.64	98.82	308.76
		h/3	226.97	113.48	369.43

CONCLUSION

- Unconfined compressive strength of untreated unreinforced soil, qu= 48.35 kN/m^2
- Stabilisation of soil (Unreinforced)
  1. For lime/flyash replacement maximum unconfined compressive strength obtained is = 171.3 kN/m^2 at 5% of flyash replacement.
  2. It gives 2.5 times more strength than untreated unreinforced soil only.
  3. For combined replacement of lime/flyash maximum unconfined compressive strength obtained is = 292.3 kN/m^2 at 8% of lime and 3.75% of flyash replacement.
  4. It gives 5 times more strength than untreated unreinforced soil only.
- Stabilisation of soil – Geotextile (Reinforced)
  1. For lime/flyash replacement maximum unconfined compressive strength obtained is = 477.84 kN/m^2 at 12% lime replacement and at h/3 depth of geotextile.
  2. It gives 18.7 times more strength than untreated unreinforced soil only.
  3. For combined replacement of lime/flyash maximum unconfined compressive strength obtained is = 339.05kN/m^2 at 8% of lime – 1.25% flyash replacement and at h/3 depth of geotextile.
  4. It gives 6.3 times more strength than untreated unreinforced soil only.
- From all the above combinations the maximum unconfined compressive strength obtained for Soil – flyash - Geotextile combination (339.05 kN/m^2) at 1.25% replacement of Flyash and 8% of lime and geotextile placed at h/3 depth.
- Soil unconfined compressive strength was found to be increasing with an increasing percentage content of flyash.
- Geotextile was found to be more efficient when double layer reinforcement was provided.
- As the number of reinforcement layer increased, unconfined compressive strength of soil was found to be increasing.

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