

Study on Strength of Peat Soil Stabilised With Cement and Other Pozzolanic Materials

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Abstract:- Peaty soils are not suitable as foundation soils as they are weak and highly compressible. The stabilization is achieved by mixing soil with binding materials such as lime and cement. The additives are added to the peat soil sample, as percentage of the dry soil mass in the range of 10%,30% and 50% respectively. The experimental results show that the addition of lime and cement improved the strength characteristics of soil. The maximum dry density of soil is found to increase while optimum moisture content is found to decrease with increase in the percentage of additives. The unconfined compression strength is also found to increase significantly with increase in percentage of the additives. When comparing the performance of lime and cement, Ordinary Portland Cement appears to perform better than the hydrated lime.

Keywords:- Peat, lime, cement, compaction test, unconfined compression strength test,

I. INTRODUCTION

Ground improvement is a rapidly developing field because good sites for construction are becoming limited day by day. It is a challenge for the engineers to construct buildings on the sites which are unsuitable and unacceptable. Peat is a highly organic soil, consisting almost entirely of vegetative matter in varying states of decomposition. It originates from plant and denotes the various stages in the humidification process where the plant structure can be discerned. The decaying process of plant under acidic condition without microbial process results in the formation of organic matter in peat. This renders peat is extremely soft and problematic type of soil. Buildings on peat soils are usually suspended on piles, but the ground around it may still settle, creating a scenario as depicted in Fig. 1.

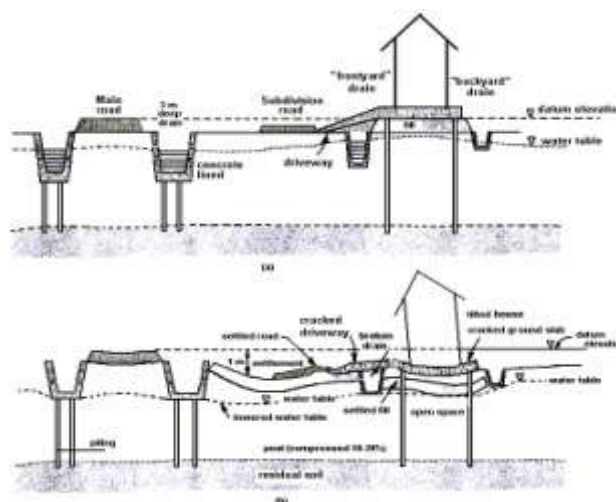


Fig.1 Typical section of a housing estate on peat (a) Immediately after completion of construction (b) Several years after completion of construction

In addition to this problem, there is discomfort and difficulty of access to the sites, a tremendous variability in material properties and difficulty in sampling are taken place. These materials may also change chemically and biologically with time. For example further humidification of the organic constituents would alter the soil mechanical properties such as compressibility, shear strength and hydraulic conductivity. Lowering of ground water table may cause shrinkage and oxidation of peat leading to humidification with consequent increase in permeability and compressibility. It is therefore understandable that constructions of buildings on

these types of soils are often avoided whenever possible. However these soils are found in many countries throughout the world. The total coverage of tropical peat land in the world is about 30 million hectares. Since the coverage of these soils are quite extensive, utilization of these marginal soils are required in increasing number of instances in the recent years. Hence suitable geotechnical design parameters and construction techniques are needed to be found for this type of ground condition. Peat actually represents an accumulation of disintegrated plant remains, which have been preserved under condition of incomplete aeration and high water content. It accumulates wherever the conditions are suitable, that is, in areas with excess rainfall and the ground are poorly drained, irrespective of latitude or altitude. Peat deposits tend to be most common in those regions with comparatively cool wet climate. Physio-chemical and biochemical process cause this organic material to remain in a state of preservation over a long period of time. It is therefore necessary to expand our knowledge on the engineering or mechanical properties of the peat and organic soils.

II. METHODOLOGY

Collection Of Soil Sample

Soil sample was collected from coonoor area near Railla Dam at a depth of 0.5m to 1m from the ground surface.



Fig 2 Soil Sample

The laboratory tests have been carried out as per IS 2720.

- a) Initial moisture content was determined using Infra-red moisture meter at 60°C.
- b) Specific gravity of the soil sample was determined using pycnometer.
- c) Organic content in the soil sample is determined by the method based on organic carbon content of soil.
- d) Grain size distribution was determined by conducting dry sieve analysis.
- e) The water content at which the soil changes from one state to other is determined by Atterberg's limit.
- f) The optimum water content and maximum dry density is obtained by conducting Standard proctor's compaction test
- g) Unconfined compression strength test is performed to determine stress-strain relationship of the soil sample.

Laboratory Test On Soil Stabilised With Lime And Cement

Standard Proctor's Compaction Test

The additives (lime and cement) are added to the soil sample in percentages 10%, 30% and 50% to the dry soil mass.

The amount of additives required to get the highest maximum dry density at minimum optimum moisture content is determined by conducting standard proctor's compaction test.

Unconfined Compressive Strength Test

The Unconfined Compressive Strength test is a special form of a triaxial test in which the confining pressure is zero.

The cylindrical soil sample is prepared at the desired water content and density obtained from standard proctor's compaction test. The specimen is then placed in unconfined compression apparatus. The compression load is applied to cause an axial strain at the rate of 0.5 to 2% per minute.

The cylindrical specimen of soil is subjected to major principal stress till specimen fails due to shearing along a critical plane of failure. The test is conducted for soil sample and different percentages of lime and cement. The percentage of additives that carries maximum load can be determined from this test.

III. RESULTS

A. PROPERTIES OF SOIL SAMPLE

The laboratory tests have been carried out as per IS 2720 and the test results are given in table 4.1.

Table I Properties Of Soil

PROPERTIES	VALUES
IS classification	Pt
Moisture content (at 60°)	12 %
Specific Gravity (G)	1.417
Organic content	6.425 %
pH	4.98
Effective size (D_{10})	0.15 mm
Fineness modulus	2.787
Uniformity coefficient (C_u)	6.733
Coefficient of curvature (C_c)	1.584
Liquid limit (w_l)	52 %
Plastic limit (w_p)	50 %
Shrinkage limit (w_s)	35.43 %
Plasticity index (I_p)	2

B. Determination Of Strength For Untreated Peat Soil

2.5 kg of dry soil sample is taken and initial quantity of water is added to it and mixed thoroughly. Then the sample is placed in the cylindrical mould fixed with detachable collar and base plate, in three layers. Each layer is given 25 blows using the standard proctor rammer uniformly over the entire area.



Fig 3 Peat Soil Mix

The Unconfined compressive strength is defined as the load per unit area at which an unconfined cylindrical specimen of soil compressed. 2.5 kg of soil is taken, water is added to it equal to the optimum moisture content. Thorough mixing is done. Generally, the specimen shall be prepared in a height equal to about twice the diameter by extruding the soil sample from the mould.



Fig 4 Testing Of Peat Soil Sample In Ucc Machine

C. Determination Of Strength For Lime Treated Soil

The lime is added to the peat soil sample as percentage of dry soil mass in the range of 10%,30% and 50% respectively.

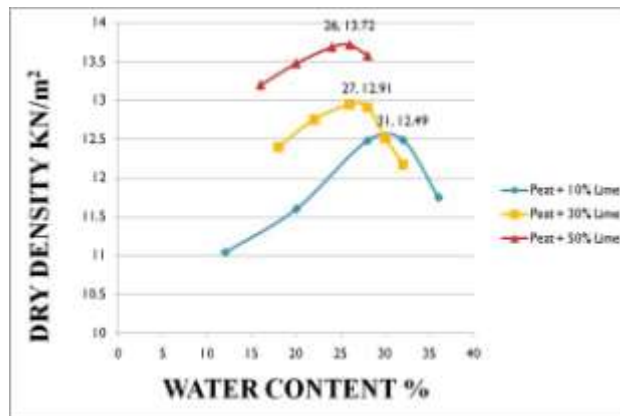


Fig 4 Ucc Test For Lime Treated Soil

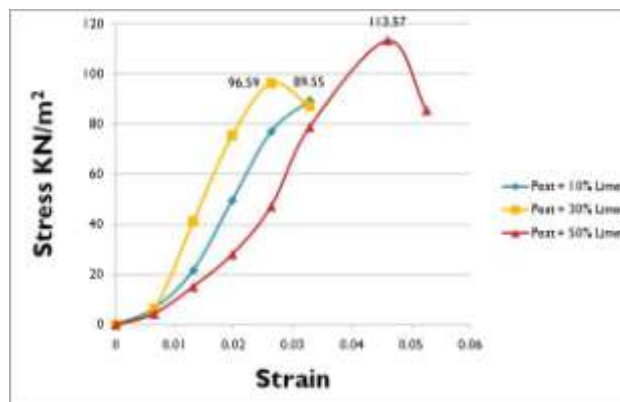


Fig 5 Stress-Strain Curves For Peat Soil Treated With Lime

D. Determination Of Strength For Cement Treated Soil

The cement is added to the peat soil sample as percentage of dry soil mass in the range of 10%,30% and 50% respectively.

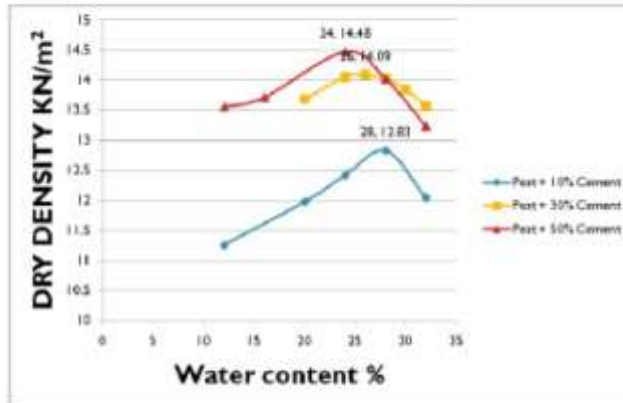


Fig 6 Compaction Curves For Cement Treated Soil

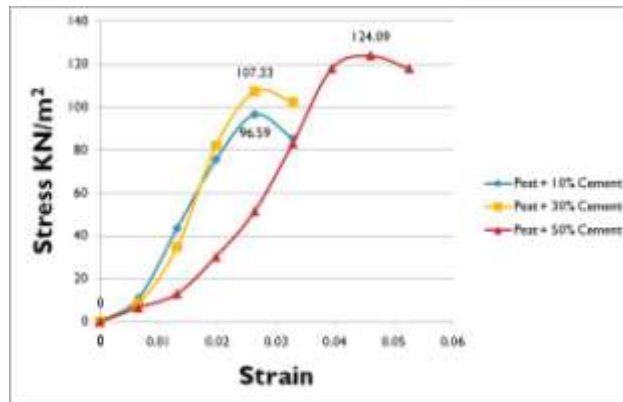


Fig 7 Stress-Strain Curves For Peat Soil Treated With Cement

Table II Comparison Of Standard Proctor’s Compaction Test Results

SOIL	PROPERTIES	
	OMC %	Maximum dry density KN/m ³
Untreated soil	35	11.71
Soil+10% lime	31	12.49
Soil+30% lime	27	12.95
Soil+50% lime	26	13.72
Soil+10% cement	28	12.83
Soil+30% cement	26	14.09
Soil+50% cement	24	14.48

Table III Comparison Of Unconfined Compressive Strength Test Result

PERCENTAGE	UNCONFINED COMPRESSION STRENGTH IN KPa	
	LIME	CEMENT
10%	89.55	96.59
30%	96.59	107.33
50%	113.57	124.09

IV. DISCUSSIONS

From table I it is clear that the maximum dry density of soil is found to increase while the optimum water content is found to decrease with increase in lime and cement content. For untreated soil the OMC is 35% and maximum dry density is 11.71 KN/m³.

For lime treated soil the decrease in OMC value is from 31% to 26% and increase in maximum dry density is about 12.49 KN/m³ to 13.72 KN/m³.

While for cement stabilised soil there is considerable decrease in OMC 28% to 24% and increase in maximum dry density value of 12.83 KN/m³ to 14.48 KN/m³.

The results obtained from Unconfined Compressive Strength tests shown in table II indicate that the addition of lime and Ordinary Portland Cement to peat soil increases the Unconfined Compressive Strength values.

The value of Unconfined Compressive Strength for untreated peat is about 54 KPa, while for the lime treated soil the Unconfined compression strength value increases from 89KPa to 113KPa and for cement treated soil is about 96KPa to 124KPa.

V. CONCLUSIONS

- 1) Peat soil is one the softest soils and is unable to resist construction loads imposed upon it. Different methods are available to improve the bearing capacity of foundation soils.
- 2) One of the common method is stabilization using additives.
- 3) The experimental results show that the addition of lime and cement improved the strength characteristics of soil.
- 4) The soil maximum dry density is found to increase with increase in the lime and cement content, while the optimum water content is found to decrease.
- 5) The unconfined compression strength of the soil is found to increase significantly with increase in lime and cement content.
- 6) When comparing the performance of lime and cement, Ordinary Portland Cement appears to perform better than the hydrated lime.

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