Geotechnical Properties of an Expansive Soil Stabilized with Quick Lime

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Abstract - Expansive soils have the tendency to undergo volume change behaviour and cause huge uplift pressures and upheaval of structures based on it due to presence of moisture. In most of the cases, practically it is not possible to avoid expansive soil and replacement of soil by any material or soil, in a larger area of expansive soil, hence stabilization processes are required to stabilize it. A lime is most useful chemical stabilizing agent. In this study, expansive soil was taken from Borkheda, Kota, Rajasthan and stabilized with quick lime. The expansive soil was treated with different percentage of quick lime 2,4,6,8,10 and specimens were cured for 3days. For the improvement of engineering properties of soil following tests were performed:- Index properties, Standard proctor, Unconfined compression strength. The tests were performed on various percentage of lime. The optimum percentage of lime is determined on the basis of differential free swelling index test. The aim of this study is to economically improve the geotechnical properties of expansive soil such that the structure built, increase the strength of flexible pavement for efficiently withstand applied loads, reduce the thickness of pavement and improve the durability of pavement.

Keywords - Expansive Soil, Quick Lime, Standard Proctor, OMC, MDD, UCS.

I. INTODUCTION

Expansive soil is also known as kali mitti, mainly find in central India and Deccan plateau such as Maharashtra, Western Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Karnataka etc. Geotech engineers are constantly searching for new and suitable engineering methods for improving the engineering properties expansive soil. In the developing country like India there is lack of land to dispose the waste that reason engineers are consistently looking for using these waste as stabilizing material for expansive soil. In this Paper present a study, carried out on soil stabilization using Quick lime for improving the engineering property of expansive soils. Various tests like liquid limit, plastic limit, plasticity index, standard proctor test, unconfined compression strength test (3days soaked), differential free swelling index were performed on the soil samples prepared by using Quick lime with expansive soil at different percentages. On the basis of the results obtained from these tests, it may be concluded that the strength of expansive soil can be substaintially improved by mixing Quick lime as stabilized materials.

II. LITERATURE REVIEW

(i). A. A. Amadi et. Al. The tests were performed to carried out and compare the quick lime and hydrated lime for stabilization effectiveness on different percentages (0, 2.5, 5, 7.5, 10%) of soil when mixed separately to locally available lateritic soil, a major soil group in the tropical and sub-tropical regions. The following tests were conduct in this research work: Atterberg limits, compaction, unconfined compression tests, California bearing ratio (CBR), swelling potential using CBR instrument and hydraulic conductivity. The soil mixtures used for unconfined compressive strength (UCS), CBR, swelling potential and hydraulic conductivity tests were compacted at optimum moisture content using the British standard light compactive effort and cured for 28 days.

(ii). Dilip Shrivastava et. Al. Concluded that an experimental work was performed for evaluate the effects of Rice Husk Ash on atterberg's limit of black cotton soil stabilized with 5%lime. Black cotton soil blended with 5% lime are treated by mixing Rice Husk Ash in 5%, 10%, 15%, and 20% ratio by weight of dry soil as per relevant. The tests were performed on the basis of IS code procedures.

(iii). Sumit shringi et. Al. Studied that the behariour of black cotton soil with various percentage of brick dust powder and lime. The following test were performed in this research work: Atterberg limits, compaction, unconfined compression tests, differential free swelling index (DFS), California bearing ratio (CBR) and evaluate the optimum percentage for improve the geotechnical properties of soil.

III. EXPERIMENTAL RESULTS

(i). Atterberg's limits:-

The consistency of a clayey soil is the physical state in which it exists. It is used to denote the degree of firmness of a soil. Consistency of a soil is indicated by such terms as soft, firm or hard. In 1911, a Swedish agriculture engineer Atterberg mentioned that a fine grained soil can exist in four states, namely, liquid, plastic, semi-solid or solid state. The moisture content at which the soil changes from one state to another are known as consistency limits or Atterberg's limits. These data are observed while tests were performed the LL, PL and Plasticity Index.

Table 1 - Atterberg's Limit for Expansive Soil and Different Percentage of Quick Lime

Particulars	Liquid limit	Plastic limit	Plasticity index

Expansive Soil	41.64	20.45	21.19
E.S. + 2% Lime	38.57	18.97	19.60
E.S. + 4% Lime	34.71	15.64	19.08
E.S. + 6% Lime	30.14	13.64	16.50
E.S. + 8% Lime	27.77	11.76	16.01
E.S. + 10% Lime	23.89	9.21	14.68

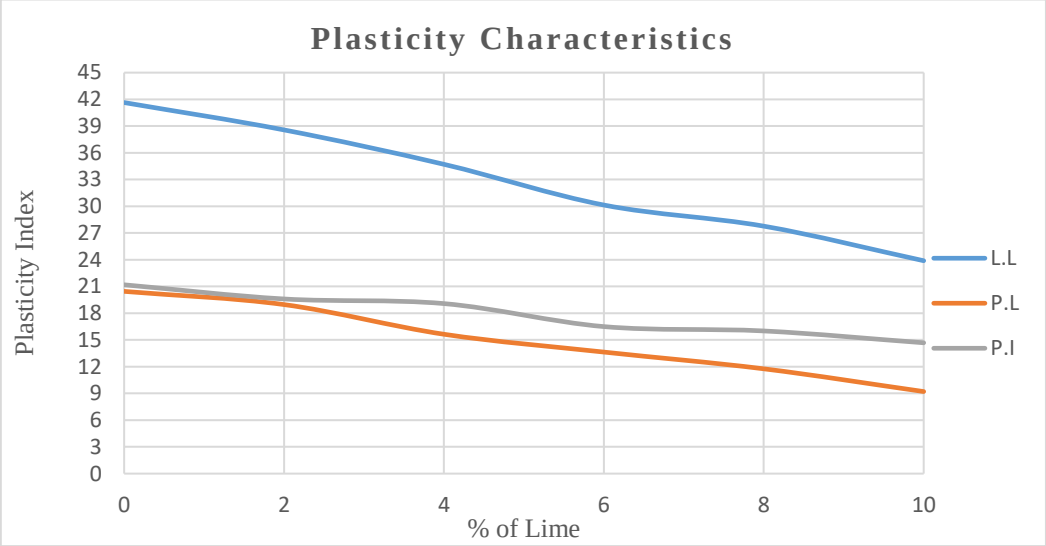

Fig. 1- Atterberg's Limit for Expansive Soil and Different Percentage of Quick Lime

(ii). COMPACTION TEST

The standard proctor test is performed for evaluate maximum dry density and optimum moisture content of soil with various percentage of quick lime and peak value of the curve is taken as OMC and MDD. Based on these results classification is done as per IS 2720 (Part VII). From table no.2 it is observed that the maximum dry density of soil 1.69 kg/cm³ with increasing the percentage of quick lime in expansive soil the maximum dry density is decreases up to 1.588 kg/cm³. Optimum moisture content of soil is 18.35% with increasing the percentage of quick lime in expansive soil the Optimum moisture content is increases up to 22.11%.

Table 2 - Standard Proctor Test for Expansive Soil and Different Percentage of Quick Lime.

Percentage Of Lime With Expansive Soil	MDD(kg/cm³)	OMC (%)
Expansive soil	1.69	18.35
E.S. + 2% Lime	1.65	19.36
E.S. + 4% Lime	1.61	20.58
E.S. + 6% Lime	1.59	21.30
E.S. + 8% Lime	1.59	21.90
E.S. + 10% Lime	1.58	22.11

Due to chemical reaction and soil-lime mechanism shows that the optimum moisture content of soil is increases by the increasing the percentage of quick lime, the floc formation occurs and the enlarged particle size causes the void ratio to increase. This increase in void ratio reflects the decrease in maximum dry density and increases optimum moisture content.

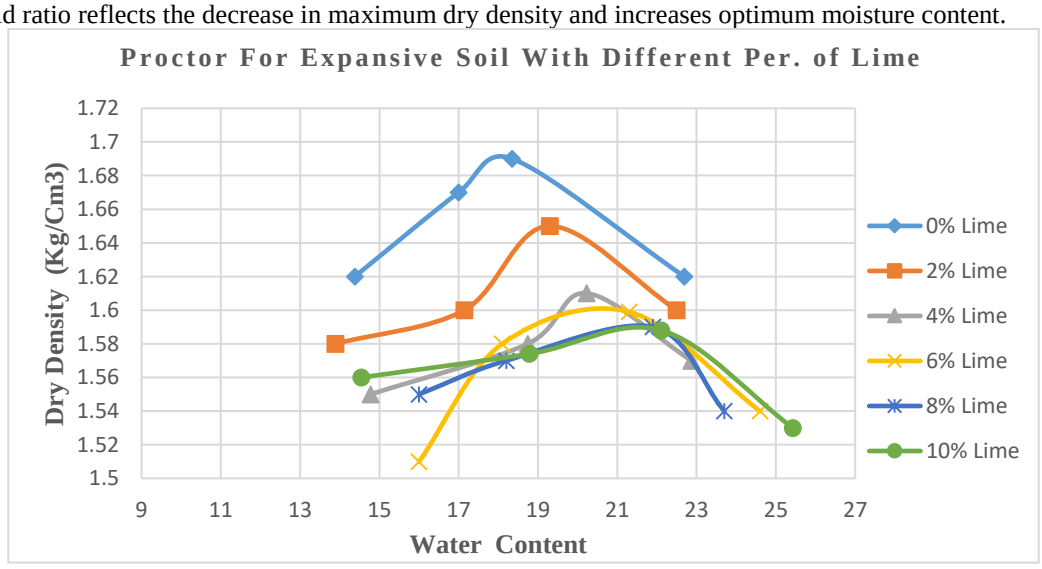

Fig. 2 - Standard Proctor Test for Expansive Soil and Different Percentage of Quick Lime

(iii). UNCONFINED COMPRESSION TEST (3DAYS SOAKED):-

The purpose of this test is to obtain a quantitative value of compressive and shearing strength of clay soils in an undrained state. The UCS test is a special form of a triaxial test in which the confining pressure is zero. The test can be conducted only on clayey soils which can stand without confinement. The test is generally performed on intact, saturated clay specimens.

Table 3 - UCS Test Results for Expansive Soil and With Diff. Per. of Quick Lime

Test Specimen (Quick lime) - %	Unconfined Compressive Strength, q_u (kg/cm^2)	Shear Strength, C_u (kg/cm^2)
Expansive Soil	2.12	1.06
E.S. + 2% Lime	3.02	1.15
E.S. + 4% Lime	3.62	1.81
E.S. + 6% Lime	4.15	2.08
E.S. + 8% Lime	4.32	2.16
E.S. + 10% Lime	2.60	1.30

Further increment of lime percentage in the expansive soil the value of compressive strength is decreased due to rearrangement of soil crystalline structure after 8% it replace soil particles and reduce the shear strength this phenomena is called dilatancy. After sometimes it regain its shear strength but less than 8% this phenomena is called thixotropy.

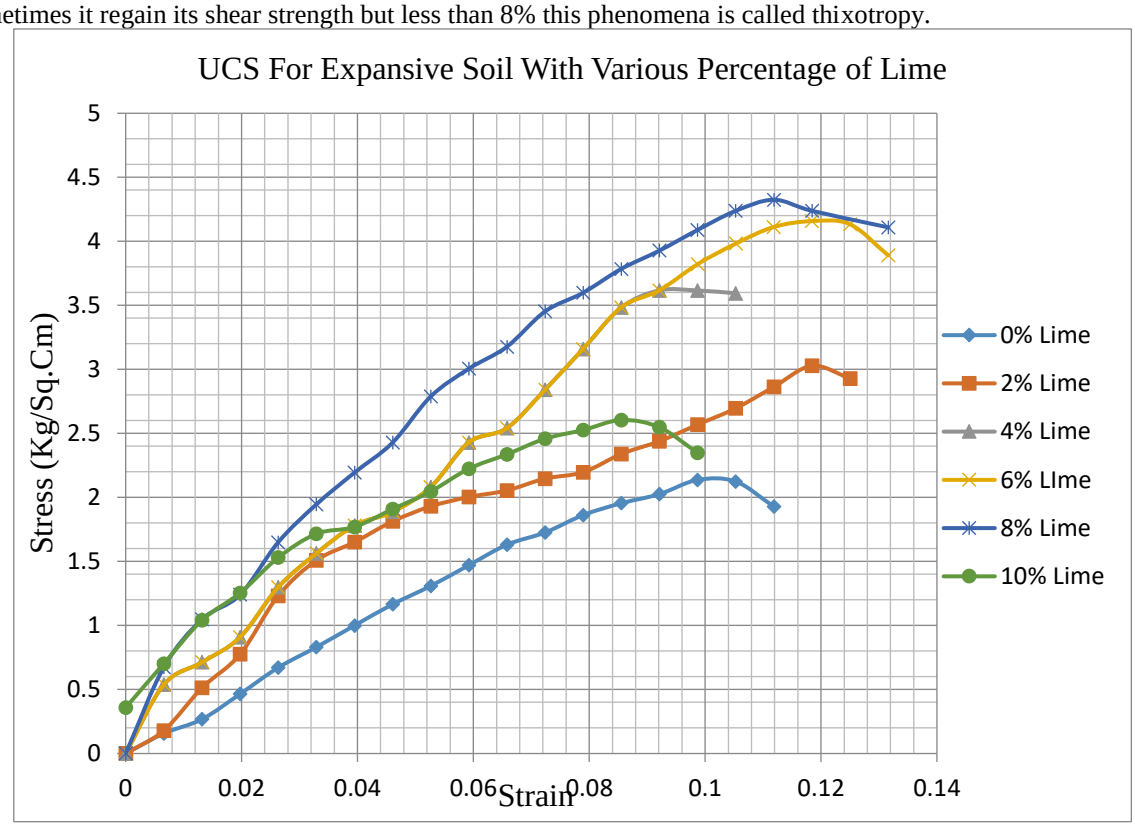

Fig. 3 - UCS for Expansive Soil and Different Percentage of Quick Lime

IV. CONCLUSION

(i) The result shows plasticity index decrease from 21.19 to 14.68.

(ii) The compaction parameters maximum dry density decreases from 1.69 kg/cm^3 to 1.58 kg/cm^3 and optimum moisture content increases from 18.35% to 22.11%.

(iii) By the increment % of quick lime unconfined compressive strength is increasing up to 8% on the further increment of lime its decreases.

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