Research Paper

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Influence of Index Properties in Swelling Pressure of Clay

Engineering

KEYWORDS : Clay, liquid limit, plastic limit, free swell, plasticity index, swell pressure, correlation

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ABSTRACT

Expansive soils exhibit significant volume changes with variations in moisture content. Foundations constructed on these soils are subjected to considerable damage due to swelling. Determination of swelling characteristics is a prerequisite for safe and economic design of structures resting on expansive soils. The major difficulties associated with the determination of Swell characteristics of soil are the difficulty in obtaining Undisturbed samples and most of the methods are rather expensive, time consuming and involve complicated test procedures. On the other hand, tests to determine index properties are quite simple and less expensive. The purpose of this study to establish correlation for the quick prediction of swell pressure of clay from the results of index properties. In this study, an attempt is made to correlate swell pressure with plasticity index and clay content. Swell Pressure tests in Constant Volume Method are performed on statically compacted 20 soil samples collected within Coimbatore Corporation limit. A correlation for obtaining Swell pressure in kN/m2 is derived.

INTRODUCTION

The rapid urban and industrial development poses increasing demands for land. Due to this space constraint, buildings are to be constructed on unsuitable grounds such as soft and expansive soils. An apparent volume change is noted when the dry clayey soil comes in contact with water. Due to the intrusion of water, the soil experiences alternate shrinkage and swelling. Expansive soils are a worldwide problem that poses several challenges to civil engineers. Foundations constructed on these clays are subjected to large uplift forces caused by swelling, and inducing heaving, cracking, and break up of both building foundations and slabs on grade members. Heave problems account for more economic loss than all other soil problems.

The swelling of soils is due to the presence of expansive clay minerals, hydration of cations on clay surfaces, and release of intrinsic stresses caused by over consolidation or desiccation of soils. Many investigations were carried out to analyze the factors affecting the swelling of clayey soils. The major factors affecting the swelling of such soils are mainly concerned with the physical properties of the particles and the mass of soil, such as plasticity index, type of clay mineral, initial dry density and clay content.

Swelling Pressure, defined as the pressure which is required to return a swelled specimen back to its original state prior to swelling. Swelling Pressure is necessary for estimation of heave and for safe and economic design of Canal linings. The objective of this study is to assess the degree of association between Swelling Pressure and each of the influencing parameters namely Liquid limit (w_L), Plasticity Index (Ip) and Maximum Dry Density. The basic fact that both Atterberg limits and Engineering properties are dependent on composition of the soil.

The study area is Coimbatore city. Samples collected fromCoimbatore cityare analyzed for its grain size distribution, Atterberg's limit, Standard Proctor Compaction, Differential free swell and swelling pressure (Constant Volume Method).

An attempt is made to establish a correlation between Swelling Pressure vs. Plasticity index and Clayey Fraction.

LOCATION OF SAMPLES:

Coimbatore city is mainly covered with black cotton soils. Structures founded on clay soil are subjected to swelling pressure is found to be high. In this work twenty locations namely GCT campus, Sowripalayam, Singanallur, KarupparayanKoil, CheranManagar, KalapattiRoad,AgriUniversity,VadaKovai,Rathinapuri, MullaiNagar,GandhiPark,narasimanaickenpalayam,krishnarayapuram,Saibabacolony,Thudiyalur,Neelambur,Sivanantacolony,Peelamedu,Kovaipudur and Eachanariin city were identified for soil sampling and laboratory analysis.

SWELL PRESSURE TEST

Swelling Pressure, defined as the pressure which is required to return a swelled specimen back to its original state prior to swelling. Swell pressure test is obtained by conducting Constant volume method as per IS 2720 (Part41) – 1997.

The sample for swell pressure test was prepared in optimum moisture content and maximum dry density is shown in fig 1.



Fig-1Swelling Pressure Apparatus

EXPERIMENTAL RESULTS

In this study correlation is developed for swelling pressure in terms of plasticity index and clayey fraction. The Correlation is in the form of linear relationship to assess swellingpressure based on the test results of all the twenty samples. The consolidated results are shown in table 1

TABLE-1 CONSOLIDATED RESULTS

S.NO	I_p %	Clay Content%	Swell pressure (kpa)
S1	40.83	40	112
S2	32.98	45.7	89.7
S3	40.5	58.2	101.2
S4	47.18	33.1	115.7
S5	31	45.3	90.5
S6	45.3	51.6	139.6
S7	43.27	35.9	94.3
S8	33.03	47.3	81.5
S9	22.7	27.8	51.7
S10	33.3	25	96.7
S11	52.4	25	155.3
S12	53.4	40.1	137
S13	37.03	38.3	125.6
S14	50.1	40	112
S15	39.2	40	97.65
S16	38.7	51.2	101.45
S17	38.8	42	99.4
S18	41.8	44.5	125.4
S19	52.1	49	132.5
S20	49.6	42	112.7

CORRELATION FOR SWELL PRESSURE

Regression Model For Prediction Of Swelling Pressure:

The multiple regression analyses were carried out to correlate the measured swell pressures to the soil properties namelyClay-ey Contentand Plasticity Index of the soil. The results are shown in Table 1.These analyses with high coefficients of multiple determination confirm the existence of strong correlations between the swell pressure and the soil properties and can be expressed asgiven below.

$P_S = f(I_P, C)$

$$(P_S) = (a_0 + a_1(C) + a_2(I_P))$$

The numerical values of regression coefficients a0, a1 and a2can be obtainedfrom multiple regression analysis. Microsoft-Excel software provides a subroutine formultiple regression analysis and the same is used here to obtain the regression coefficients a_0, a_1 and a_2. Theregression model so obtained is given below.

$P_S = 20.3 - (0.0245*C) + (2.196*I_P)$

Where

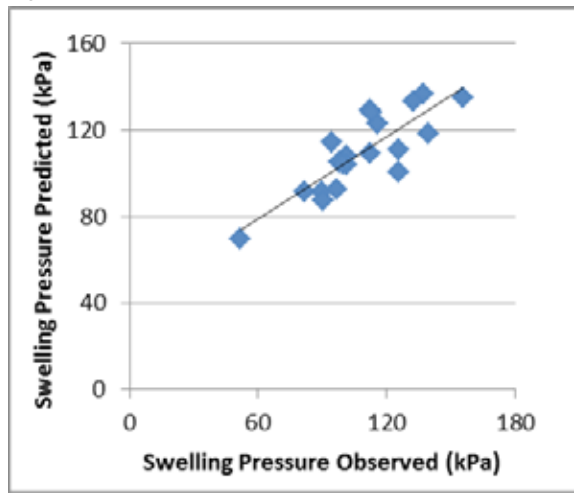
P_S Initial Dry Density in kN/m3.

C Content in fraction(%).

I_P Plasticity Index (%).

These results with high coefficients of multiple determination confirm the existence of strong correlations between the swell pressure and the soil properties. The swell pressures obtained from Equation are compared with the measured swell pressures. A plot is developed to compare the derived correlation with the measured Swelling pressure values as shown in figure 2

Fig-2 Comparison Plot



CONCLUSION

In this study, efforts were made to develop multiple regression analysis (MRA) model that can be employed for estimating swell pressure.The data trends and the statistical analysis presented throughout the study reveals the following:

The swell pressure is strongly dependent on clay content and plasticity index.

Significant correlations exist between the swell pressure and the soil properties, and revealed a simple regression equation for a quick prediction of swell pressures from easily determined soil properties in kPa is developed as below.

$P_S = 20.3 - (0.0245*C) + (2.196* I_P)$.

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