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A STUDY OF CORRELATION BETWEEN SWELLING PRESSURE AND PHYSICAL PROPERTIES OF SOME SOILS

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Abstract - For safe and economic design of structures to be constructed in expansive soils study of swelling properties is an important prerequisite. The volume change in swelling soils are the cause of many problems in structures that come into their contact. The laboratory test method for finding swelling pressure of any soil is time consuming and expensive. The laboratory test for the determination of consistency limits and differential free swell are relatively easy and consume less time. In this study, swelling pressure of some soils collected from different parts of Jabalpur city are correlated with index properties like liquid limit (LL), plastic limit (PL), plasticity index (PI) and differential free swell (DFS). The correlation is established using data analysis tool pack of Microsoft excel.

Keywords: Swelling Pressure, Coefficient of correlation (R^2), MLRA, Regression, SLRA

I. INTRODUCTION

Expansive soils or swelling soils are those soils which have the tendency to increase in volume when water is available and to decrease in volume if water is removed. The soils are very hard in dry state and possess a high shearing strength which gets reduced appreciably with the ingress of water. Construction in expansive soils poses several challenges to civil engineers. This Foundations constructed on these expansive soils are subjected to large uplift forces caused by swelling and inducing heaving, cracking and break up building foundations and slabs on grade members.
The engineering behavior of a soil mass is greatly influenced by physical properties of particles, the type of clay mineral, the proportion of the soil grains forming the soil mass and index properties.

Swelling pressure, defined as the pressure which is required to return a swelled specimen back to its original state prior to swelling. Swelling pressure can be directly measured in laboratory in accordance with IS 2720 – PART XLI. Laboratory test for swelling pressure is a lengthy process. Also the swelling pressure of soil is influenced by different soil properties like LL, PL, PI, etc. and also these tests are quick and easy to perform.

Previously various attempts have been made to correlate the swelling pressure with other properties. Erzin and Erol (2004) studied the correlation for quick prediction of swell pressures. Basma and Al- hamoud (1995) did laboratory assessment of swelling pressure of expansive soils. Jeevanantham, Arumairaj and Sathees Kumar (2015) used regression analysis to assess Influence of Index Properties in Swelling Pressure of Clay.

II. EXPERIMENTAL WORK

Six types of soil having different clay content were collected from different parts of Jabalpur region (MP) India. Different tests like sieve analysis for initial classification according to Unified Soil Classification System, liquid limit and plastic limit of each of these six samples were performed. Differential free swell test and finally swelling pressure tests by consolidometer method of each sample was performed. All the tests were performed as per the specifications of the IS code of practice. Following were the observation recorded after conducting the tests.

III. RESULTS AND DISCUSSION

Table 3.1 gives a list of results of the experimental work performed on six number of samples. Further the calculations have been done based on simple linear and multiple linear regression analysis.

Simple linear regression analysis is used to relate the welling pressure of soil with individual soil properties like LL, PL, PI and DFS. Figure 3.1 shows variation of liquid limit with the swelling pressure value. The value of R^2 was found to be 0.946.

From Fig. 3.2 it can be seen that the relationship between plasticity index and swelling pressure is linear with a coefficient of correlation $R^2 = 0.984$.
Figure 3.3 shows relation between differential free swell and swelling pressure with a coefficient of correlation of 0.953.

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Table 3.1 : Results from Laboratory Tests

Sample	% Finer (75 μ)	LL	PL	PI	Classification	DFS (%)	SP (KN/m^2)
1	89.1	5 6.15	26.96	29.19	CH	43.85	37.62
2	96.4	35.46	14.66	20.80	CI	28.47	32.24
3	91.5	28.68	11.45	17.23	CL	23.47	26.87
4	94.5	66.48	24.79	41.69	CH	52.15	59.10
5	62.4	15.40	6.13	9.27	ML	11.00	10.74
6	48.6	0	0	0	SM	0	0

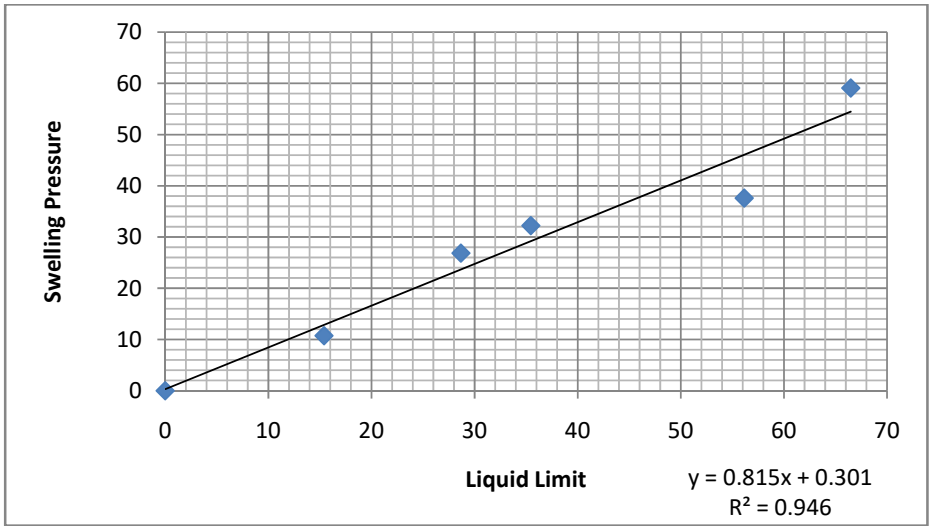

Figure 3.1: Variation of Swelling Pressure with LL

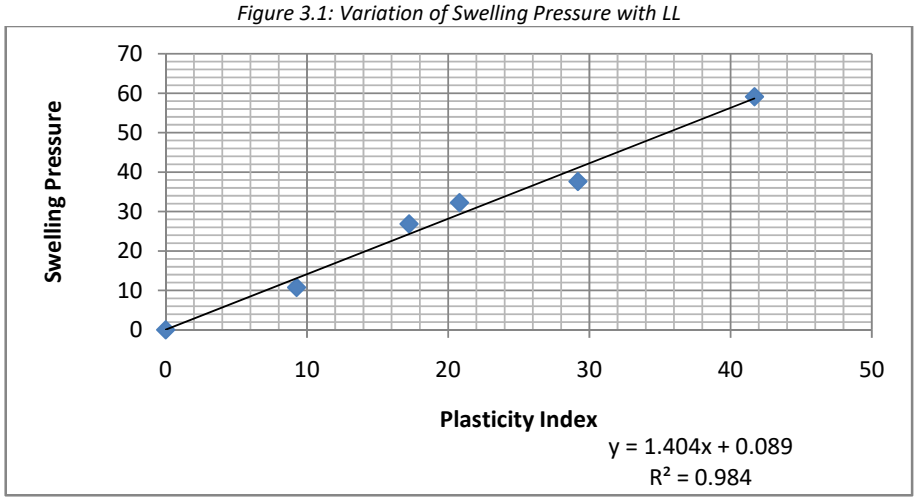

Figure 3.2: Variation of Swelling Pressure with PI

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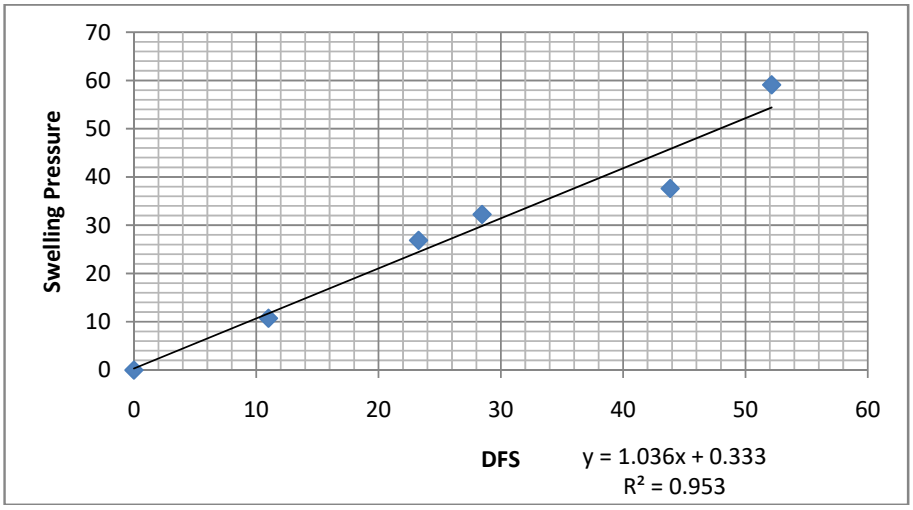

Figure 3.3: Variation of Swelling Pressure with DFS

As the main aim of this study was to develop a correlation between the swelling pressure of the soil and soil properties like LL, PI, DFS a multiple regression model is developed using the data analysis pack of Microsoft excel. The mathematical equation developed is as follows:

SP= 0.22 - (2.15*LL) + (2.29*DFS) + (1.97*PI)

The coefficient of correlation (R^2) for the above equation was found to be 0.98. Hence the equation holds good in correlating the swelling pressure with other soil properties. From the comparison of the Swelling Pressure obtained from laboratory and Swelling Pressure obtained from above equation the following table and figure is obtained.

Table 3.2 : Comparison of Lab and Predicted Swelling Pressure

Sample	Laboratory SP (KN/m^2)	SP From equation (KN/m^2)
1	37.62	37.41
2	32.24	32.3
3	26.87	26.24
4	59.10	58.84
5	10.74	10.56
6	0	0.22

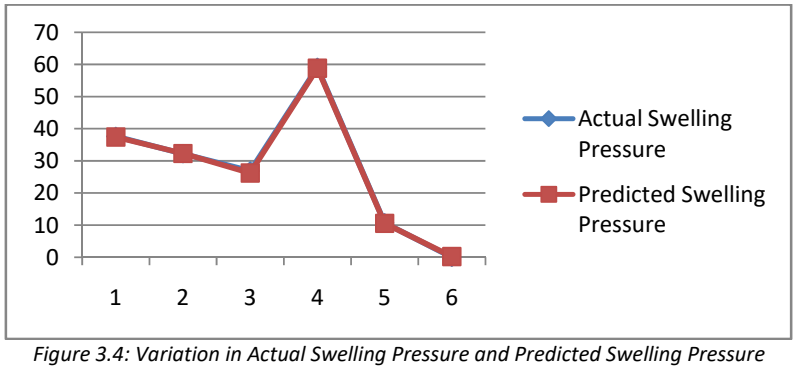

Figure 3.4: Variation in Actual Swelling Pressure and Predicted Swelling Pressure

IV. CONCLUSION

From the above study the following conclusions are made.

- Swelling Pressure of soil increases with increase in LL, PI and DFS.
- There is a slight difference between the swelling pressure values of the laboratory and that obtained from the equation.
- From regression analysis coefficient of correlation (R^2) for the swelling pressure is found to be 0.98.
- From the formula and table 3.2, it can be concluded that the correlation equation can be used for evaluating different values of Swelling Pressure.

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