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CORRELATION FOR PREDICTION OF SWELLING PRESSURE USING DIFFERENTIAL FREE SWELL AND PLASTICITY INDEX

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Abstract - Expansive soil have tendency to change significantly in volume with variation in water content. The volume change in such soils causes considerable damage in structures that come into their contact. For safe and economic design of structures to be constructed in expansive soils study of swelling properties is an important prerequisite. Assessing Swelling Pressure of any soil is a time consuming and expensive job involving complicated test procedures in comparison to determining index properties. An attempt is made to establish a correlation among Differential Free Swell, Plasticity Index and Swelling Pressure to obtain an approximate value of Swelling Pressure in short time. In present study six types of soil (having different index properties) were collected from different areas of Jabalpur district (MP). The method uses single variable and multiple variable regression analysis 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. This volume change in swelling soils is the cause of many problems in structures that come into their contact or constructed out of them. 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. Clay soils containing montmorillonite mineral swell considerably upon imbibing water from outside. Clay soils containing other clay minerals do not exhibit the volume change characteristic to the same degree as those of containing montmorillonite mineral.

Swelling pressure, defined as maximum force per unit area that needs to be placed over a swelling soil to prevent volume increase. The objective of this study is to establish a correlation among Differential Free Swell (DFS), Plasticity Index (PI) and Swelling Pressure (SP) to obtain an approximate value of Swelling Pressure in short time.

Previously Kamil Kayabali and O. Yaldiz (2012) did investigation of the relationship between swelling pressure and shrinkage limit. V. Jeevanantham, P.D. Arumairaj and V. Sathees Kumar (2015) assessed Influence of Index Properties in Swelling Pressure of Clay. Also Y. Erzin and O. Erol (2004) established correlations for quick prediction of swell pressures.

II. EXPERIMENTAL WORK

For the purpose of this study six types of soil having different clay content were collected from different locations of Jabalpur district (MP) India. These samples were initially classified according to Unified Soil Classification System. For this purpose samples were individually washed and passed through 75 µ IS sieve and the mass retained was dried and weighed. Further the liquid limit and plastic limit of each of these six samples was calculated. Differential Free Swell test and finally Swelling pressure tests by Consolidometer method as given in IS 2720 (Part XLI)-1977 of each sample was performed. The results obtained are tabulated as below.

III. RESULTS AND DISCUSSION

Table 3.1 gives us the information about the classification of the soil sample and its Swelling Pressure value. The further calculations are done using regression analysis tool from data analysis tool pack of Microsoft excel. The following graphs were observed.

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Results from Laboratory Tests							
Sample	% Finer (75 µ)	LL	PL	PI	Classification	DFS (%)	SP (KN/m^2)
1	89.1	56.15	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

Table 3.1: Results from Laboratory Tests

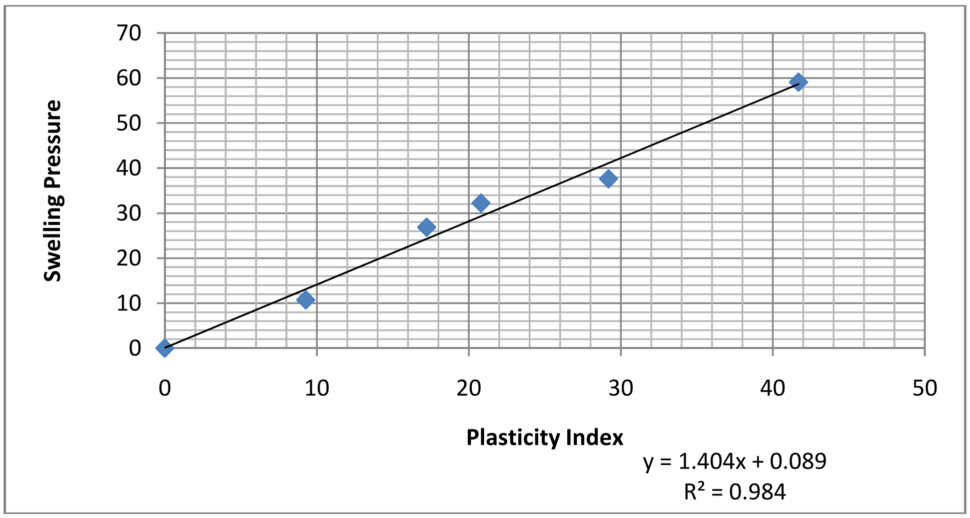

Figure 3.1: Variation of Swelling Pressure with PI

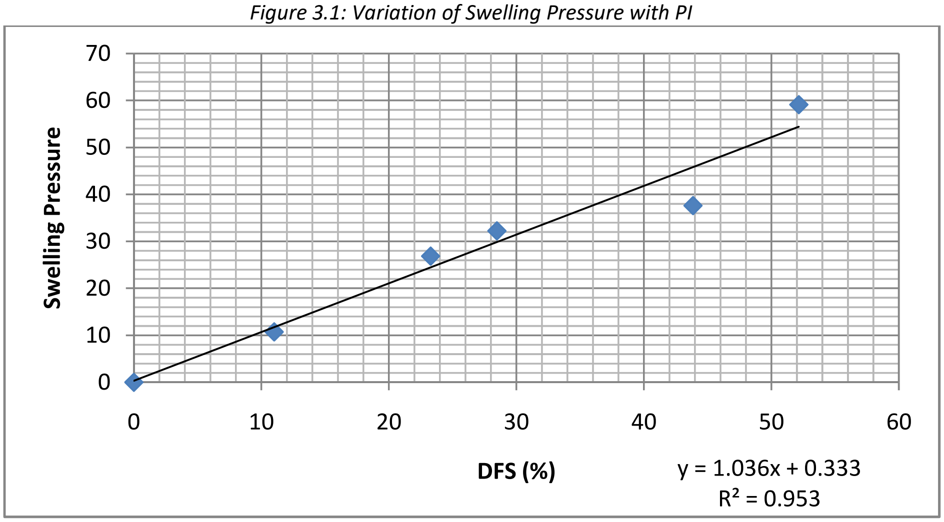

Figure 3.2: Variation of Swelling Pressure with DFS

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From the above graphs it is clear that there exists a good relation between the plasticity index and swelling pressure value of the soil, and also between swelling pressure and DFS of soil, as it has a coefficient of correlation (R^2) value of 0.984 and 0.953 respectively. This shows that the index properties and DFS of soil may be used in prediction of swelling pressure of the soil.

From the correlation analysis the predicted Swelling Pressure value has a correlation coefficient of 0.986 which is visibly good. The equation is:

SP= 0.24 - (0.31*DFS) + (1.81*PI)

The laboratory Swelling Pressure and actual Swelling Pressure is shown in Table 3.2.

Table 3.2 : Actual and Predicted Swelling Pressure

Sample	Actual SP (KN/m^2)	Predicted SP (KN/m^2)
1	37.62	39.48
2	32.24	29.06
3	26.87	24.15
4	59.10	59.53
5	10.74	13.60
6	0	0.24

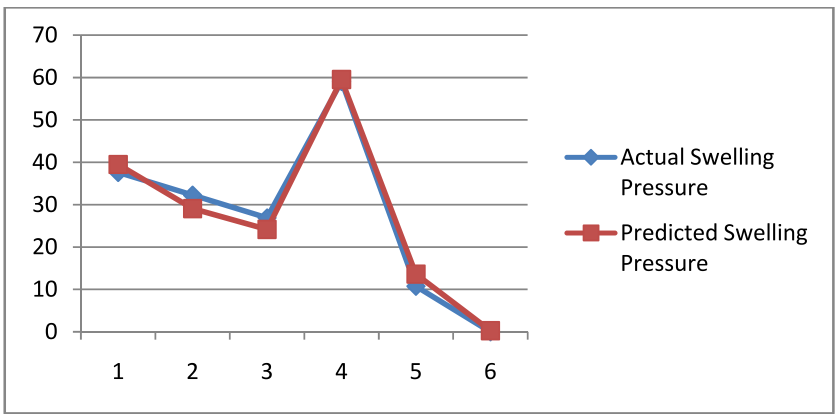

Figure 3.3: Variation in Actual Swelling Pressure and Predicted Swelling Pressure

IV. CONCLUSION

- Swelling Pressure of soil increases with increase in PI and DFS.
- The coefficient of correlation is observed as 0.984 and 0.953 respectively, hence there exist a good correlation between swelling pressure and the plasticity index and also between swelling pressure and DFS.
- The predicted values of the swelling pressure are close to the laboratory obtained swelling pressure.
- The coefficient of correlation for swelling pressure value found from regression analysis is found to be 0.986.

REFERENCES

1. IS 2720 (Part XLI) – 1977 reaffirmed 1997; Indian Standard methods of test for soils, measurement of swelling pressure of soils. Bureau of Indian Standards, New Delhi.

2. IS 2720 (Part XL) – 1977 reaffirmed 1997; Indian Standard methods of test for soils, determination of free swell index of soils. Bureau of Indian Standards, New Delhi.

3. IS 2720 (Part V) – 1985 reaffirmed 1995; Indian Standard methods of test for soils, laboratory determination of liquid and plastic limit. Bureau of Indian Standards, New Delhi.

4. IS 1498 – 1970 reaffirmed 1997; Indian Standard Classification and Identification of

soils for general engineering purposes. Bureau of Indian Standards, New Delhi.

5. Kayabali Kamil and Yaldiz O. (2012): "Investigation of the relationship between swelling pressure and shrinkage limit" EJGE, Vol.17.Bund.P pp.2313-2325.

6. Jeevanantham. V., Arumairaj P.D., Sathees Kumar V. (2015): "Influence of Index Properties in Swelling Pressure of Clay" IJSR-International Journal of Scientific Research Vol.4, Issue 6, pp.159-160.

7. Erzin, Y. and Erol, O., (2004). "Correlations for quick prediction of swell pressures" EJGE-Electronic Journal of Geotechnical Engineering Vol. 14 No. 1, pp. 78-87.

8. Basma, A. A., Al-hamoud, A. S., and Malkawi, A. H., (1995). "Laboratory assessment of swelling pressure of expansive soils". Applied Clay Science, 9, pp. 355-368.

9. Sridharan, A. and Prakash, K. (2000): "Shrinkage limit of soil mixtures" Geotechnical Testing Journal 23(1), pp. 3-8.

10. Nayak, V. and Christensen, R. W., (1971). "Swelling characteristics of compacted expansive soils" Journal of Clays and Clay Minerals, Vol. 19, pp.251-261.

11. Ranjan G., Rao, A. S. R., Second Edition (2000): "Basic and Applied Soil Mechanics" New Age International Publishers.