CORRELATION BETWEEN SWELLING PRESSURE AND FREE SWELL OF GREATER CAIRO CITY EXPANSIVE SOILS – A CASE STUDY

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ABSTRACT

The aim of this research is to investigate experimentally the relationship between free swell, plasticity index of expansive soil found in greater Cairo City Suburbs, Egypt with swelling pressure of mentioned soil. Predicting Swelling Pressure of any soil is a time consuming and expensive test in comparison to determining plasticity index and free swell which are simple, fast and economic tests. In present research six samples of expansive soil were collected from different locations of study area. The method uses single variable and multiple variable regression analysis using Microsoft excel software.

Keywords: expansive soil, swelling pressure, free swell, plasticity index, regression analysis

INTRODUCTION AND LITERATURE REVIEW

expansive soils are those soils which undergo significant increase in volume in case of wetting and to decrease in volume or shrinkage when dried. Light weight engineering structures such as pavements, single story buildings, railways and walkways may experience severe damages when they are founded on such soils, therefore determining swelling pressure caused by their expansion are essential in geotechnical engineering. The swelling of a soil is influenced by physical properties of particles, the type of clay mineral. Clay soils containing montmorillonite mineral swell considerably in comparison with clay soils containing other clay minerals. Swelling pressure is defined as the pressure that needs to be placed over a swelling soil to prevent its volume increase. The aim of this research is to obtain a correlation between Swelling Pressure (SP), Free Swell (FS) and Plasticity index (PI).

Attempts have been made by many researchers to correlate Swelling Pressure with various index properties which includes work done by: **Komarnik & David (1969), Nayak & Christensen (1974), Chen (1975), Brackley (1975), Mowafy et al. (1985)**.

more recent work on this topic includes work done by:

Y. Erzin and O. Erol (2004), they established correlations for quick prediction of swell pressures. **Kamil Kayabali and O. Yaldiz (2012)**, they investigate the relationship between swelling pressure and shrinkage limit. **V. Jeevanantham, P.D. Arumairaj and V. Sathees Kumar (2015)**, they assessed Influence of Index Properties to Swelling Pressure of Clay. **Shweta Kushwaha, R. K. Yadav (2016),** they obtained a correlation for prediction of swelling pressure value (SP) from plasticity index (PI) and differential free swell (DFS).

EXPERIMENTAL WORK

This research is based on results of 6 soil samples taken from different locations of studied area as shown in table (1) and Fig, (1). The samples selected at this zones based on history of damaged buildings due to expansive soils.

Table (1) Locations of Samples

Sample (No.)	Location
1	Degla, Maadi District, East Cairo
2	Dream Land, 6th October City, West Cairo
3	Carrefour, Maadi District, East Cairo
4	Northern Extensions, 6th October City, Wast Cairo
5	Andalus, Fifth Tagamo District, East Cairo
6	Somid District, 6th October City, West Cairo

Fig. (1) Sample Locations

These samples were classified according to Unified Soil Classification System. The liquid limit and plastic limit of each of these six samples were calculated. Free Swell test and Swelling pressure tests using Oedometer method as ASTM (D-4564) of each sample was performed. The results obtained are given in table (2).

Table (2) Laboratory tests results

	Lab tests results							
Sample No.	**% pass # 200**	**Description**	**Classification (USCS)**	**L.L. (%)**	**P.L. (%)**	**P.I. (%)**	**Free swell (FS) (%)**	**Swelling pressure (SP) (kN/m^2)**
1	100	Brown Hard Silty Clay	CH	71.4	33.8	37.6	115	250
2	100	Yellowish Brown Hard Silty Clay	CH	69	33.2	35.8	103	220
3	100	Yellowish Brown Hard Silty Clay	CH	70.5	31.5	39	125	300
4	86	Yellowish Brown Hard Silty Clay with some Sand	CH	64.3	31.9	32.4	89	200
5	85	Brown Hard Silty Clay with some Sand	CH	65.3	32.2	33.1	94	210
6	84	Brown Hard Silty Clay with some Sand	CH	63.6	32.8	36.2	108	235

Results and discussion

Figs. (2-3) show the relationship between swelling pressure versus free swell, plasticity index respectively. It was observed that the swelling pressure of expansive soil increases with increase of free swell and plasticity index, therefore a good relation between swelling pressure, free swell and plasticity index was obtained.

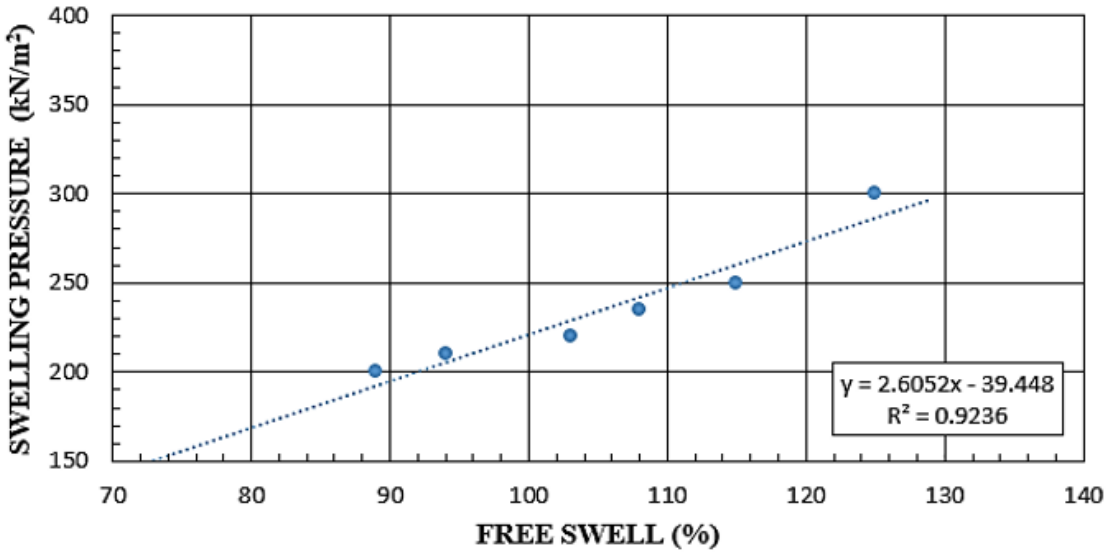


Fig. (2) Swelling Pressure Vs Free Swell

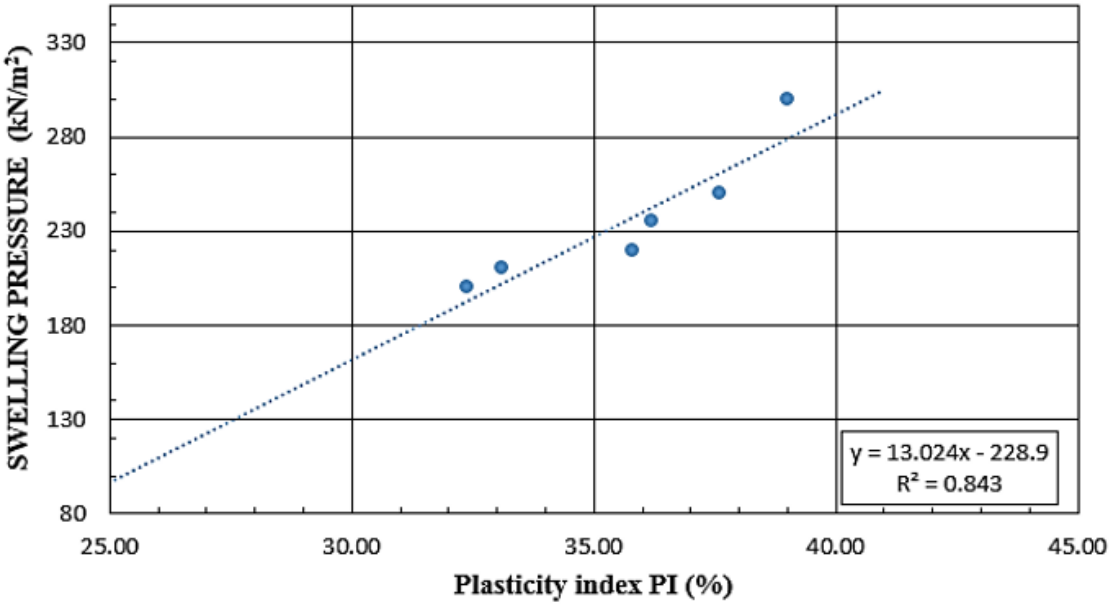


Fig. (3) Swelling Pressure Vs Plasticity Index

The coefficient of correlation R^2 between swelling pressure and free swell was 0.92. Also, for the relationship between swelling pressure and plasticity index the coefficient of correlation was 0.84. From these values it was concluded that plasticity index and free swell can be used to predict swelling pressure of expansive soil using the following equation:

SP = 302 + (6.71*FS) - (21.74*PI)

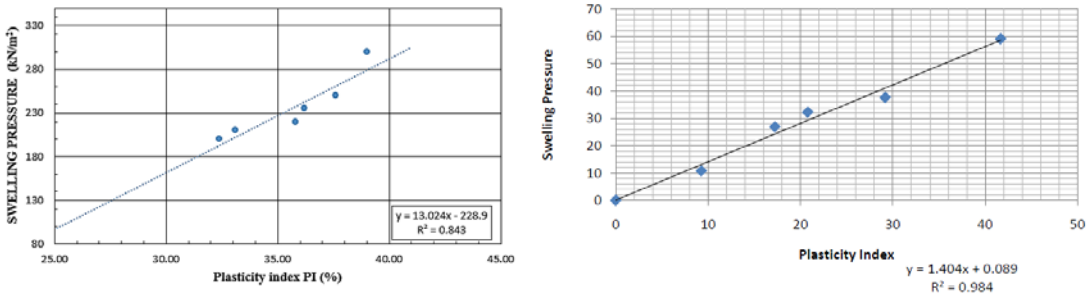
Table (3) Shows a comparison between Swelling Pressure obtained by previous equation and actual Swelling Pressure obtained from laboratory tests.

Table (3) Predicted vs Lab values of Swelling Pressure (SP)

Sample No.	Lab SP (kN/m^2)	Predicted SP (kN/m^2)
1	200	195
2	210	213
3	220	215
4	235	240
5	250	256
6	300	293

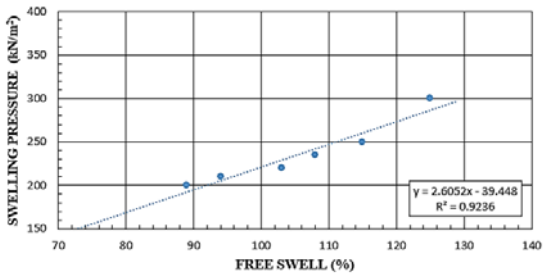
Comparison with previous research

It was observed that the increase in swelling pressure (SP) is associated with the increase in free swell (FS) and plasticity index (PI) which is similar to results obtained by **Shweta Kushwaha, R. K. Yadav (2016)** as shown in figs. (4-5) where it was observed that the relationship between swelling pressure (SP) plasticity index (PI) and free swell (FS) have similar trend.

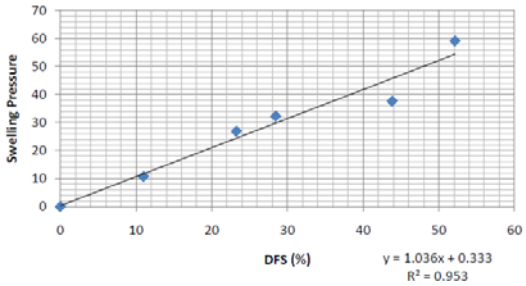


(a) Present work **(b) Shweta Kushwaha, R. K. Yadav (2016)**

Fig. (4) Swelling pressure vs Plasticity index for present work and work done by Shweta Kushwaha, R. K. Yadav (2016)



(a) Present work



(b) Shweta Kushwaha, R. K. Yadav (2016)

Fig. (5) Swelling pressure vs free swell index for present work and work done by Shweta Kushwaha, R. K. Yadav (2016)

CONCLUSIONS

Based on the results obtained, the following conclusions were obtained:

- The swelling pressure (SP) of expansive soil increases with increase of free swell (FS) and plasticity index (P.I.) of soil.
- The coefficient of correlation R^2 between swelling pressure (SP) and free well (FS) was 0.92 which indicates a good correlation between (SP) and (FS).
- Also the coefficient of correlation R^2 between swelling pressure (SP) and plasticity index (P.I.) was 0.84 which indicates a good correlation between (SP) and (P.I.).
- Plasticity index and Free Swell tests can be used to predict Swelling Pressure of expansive soil found in greater Cairo Zone.

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