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Field and Laboratory Studies on Certain Swelling Clayey Soils in Egypt

By

A. Helmi El Ramli
D.I.C., M.Sc, Ph.D.
Professor of Soil Mechanics and Foundations
Faculty of Engineering
Cairo University.

Mostafa Eldemery
M.Sc, Ph.D.
Building Research Institute
Cairo.

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Introduction

The swelling of dry soils in A.R.E. constitutes one of the challenging construction problems. In this paper a certain site was chosen for the construction of a large industrial plant where geological conditions lead to the formation of large depths of variegated shales containing some portions of swelling soils. A great part of such soils is relatively weathered. However the lower horizons are relatively intact and are formed of several layers of silty clay or interlayers of clays and fine sands in addition to occasional gypsiferous bands.

The general practice in Egypt when dealing with expansive soils, so far, was to found the structure on a cushion of sand with varying depth to "absorb" the swelling energy while the foundation is being reinforced with semelles in both directions. While this practice holds good for light construction, it may not prove satisfactory for structures of complex statical systems. This was also evidenced in some public buildings in many parts of the country that lie in the arid zones. The subject matter of this paper deals with one site where heavy construction is proposed & where extensive laboratory and field testing programs were made.

Soil Conditions

Three borings were made in the site and several samples were secured. Boring sections and relevant soil description are given in Fig. 1.

Soil Testing

Experience with various soil types in Egypt can help in determining the swelling nature of soils visually. However in the present work the swelling nature was determined by a simple test on cut specimens subjected to water infiltration and then measuring its deformation (Fig. 2) . The swelling specimens were thus reserved for future testing program. The testing program comprises the measuring of the free swelling as well as the swelling pressure.

While the term " free swelling" is self explanatory, the term " swelling pressure" is in some ways controversial. By "Swelling pressure" some engineers refer to that pressure that causes no swelling in the test specimen and hence in the soil underneath a foundation.

The swelling pressures measured in this way can be practically useful in cases of large rafts (as compared to the clay thickness) supporting a structure of relatively heavy weight i.e. exerting a pressure on the soil comparable to this said "swelling pressure". In case of footing foundations, the term may be completely misleading and a certain school in upper Egypt suffered upward movements of several centimeters and severe consequences were also sustained by the reinforced concrete skelton structure. Some engineers however, consider the "swelling pressure" as that pressure producing, in the test specimen, a certain value of swelling. Although this is a more realistic aproach

from the design point of view, it still bears to some extent the same misgivings as mentioned above.

Field testing also comprises the measurement of the "free swelling" together with loading tests on 70x70 cms test footing loaded (on the dry) by stresses of 0.5 & 1.5 Kg/cm^2 before the supporting soil is flooded. Laboratory swelling tests require a pre-determination of the time necessary for any sample to come to equilibrium with respect to water absorption. A special testing device was arranged (Fig. 3) where the soil sample is fitted in a ring and water is allowed to seep into it. The sample top touches a rod connected to a proving ring. The proving rings used have several flexibilities. The time for the proving ring to stop deformation is taken as the equilibrium time. Ranges of time were so small and bear almost no relation to the proving ring characteristics.

I. Laboratory Tests

Determination of swelling pressure Ps:

This has been done by two methods :-

a- The method of saturating the soil under constant volume :-

In this type of test the soil sample is brought to equilibrium under the effect of a percolating water (due to small hydraulic gradient) while its volume is kept constant by an arrester(Fig.4), till the sample is fully saturated. At this stage the sample is loaded in the same as a compression sample. The load causing a deformation of 0.2% is considered conventionally as equal to P_s. Whether