Design of Foundations for Light Structures on Expansive Soils

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INTRODUCTION

The design of foundations for light structures on expansive soils is more complex and more critical than that for non-expansive soils sites. It will be more expensive to develop a site having expansive soils than a site with non-expansive soils, and the cost of poor design will have more costly effects. Foundations will cost more, and most likely the site investigation and foundation design will cost more as well. Although soil sampling methods are generally similar to those for other sites, the laboratory testing, analysis, and design are more complex. Soils must be characterized to deeper depths, and the movement of water even in unsaturated zones must be considered.

Attention was focused on expansive soils approximately 30 to 40 years ago, when construction on such soils was observed to experience damage different from what engineers were accustomed to seeing. In many instances, damage due to heave was attributed to settlement. During construction of the Friant-Kern canal much research was initiated, and a significant jump in the "learning curve" occurred. Much of the early work in this area was done in California. The soils there were of a clay nature and experienced moderate to low expansion potential. Construction and design procedures were developed to deal with their problems. Portions of Texas have black cotton soils which may have very high expansion potential. Procedures were developed for construction on these soils commonly using stiffened mat designs.

In the Front Range area of Colorado, a different type of expansive soil was encountered. There the soils were highly over-consolidated claystone and clayshale of the Pierre and Denver formations. These soils exhibit very high expansion potential with very high swelling pressure. These soils exist over a wide area and extend into Canada. In the colder climates, it is common for structures to have basements to keep foundations below frost depth. The pier and grade beam system was developed for these areas, and the basement walls typically serve as the grade beam. Other foundation systems, such as over-excavation and replacement with non-expansive soil are used. Stiffened mat foundations are used less frequently.

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The geotechnical engineer typically does not perform the structural design, but is called upon to provide the geotechnical input for the design. This includes determination of the soil properties, and computation of soil, slab, and pier movement. In this paper, the important factors to be included in such computations are presented. The movement of water in the subsoils, particularly in the unsaturated zones are discussed and field observations are presented. Methods of predicting free-field heave are reviewed and comparisons are made between predicted values and observations. Pier design including methods for both rigid and elastic piers is presented. The force in the piers is computed for use in designing the reinforcing steel. Input parameters for stiffened mat foundations are discussed. Example calculations are presented and discussed.

The manuscript of this paper is available upon request from Engineering Analytics, Inc.