Foundation size effect on modulus of sub grade reaction on Sandy soils

M.Janbaz[1], S.Janbaz[2]

1- Department of Civil Engineering, International University of Imam Khomeini, Qazvin, Iran
2- Department of Civil Engineering, Tabriz University, Tabriz, Iran

Masoud_cello@yahoo.com

Abstract

Winkler model is one of the most popular models in determining the modulus of sub grade reaction. In this model, the sub grade soil is assumed to behave like infinite number of linear elastic springs. The stiffness of these springs is named as the modulus of sub grade reaction. This modulus is dependant to some parameters like soil type, size, shape, depth and type of foundation. The direct method for estimating the modulus of sub grade reaction is plate load test that is done with 30-100 cm diameter circular plate or equivalent rectangular plate. Afterward, we have to extrapolate the test value for exact foundation. In the practical design procedure, Terzaghi's equation is usually used to determine the modulus of sub grade reaction for exact foundation, but there are some uncertainties in utilizing such equation. In this paper the size effect of foundation on sandy sub grade with use of finite element software (Plaxis 8.2) is proposed to investigate the validation of Terzaghi's formula on determination of sub grade reaction modulus. Also the comparison between Vesic's equation, Terzaghi's one and obtained results are presented.

Keywords: Sub grade reaction modulus, Terzaghi's equation, Mat foundation, Plate load test

1. INTRODUCTION

Soil medium, because of the nonlinear, stress-dependant, anisotropic and heterogeneous nature, has very complex mechanical behavior. Hence, instead of modeling the subsoil in its three-dimensional nature, subgrade is replaced by a much simpler system, called a subgrade model that dates back to the nineteenth century. Searching on this concept leads to two basic approaches, which are Winkler approach and the elastic continuum model. Both of these models are of widespread use, both in theory and engineering practice.
Winkler (1867) was assumed the soil medium as a system of identical but mutually independent, closely spaced, discrete and linearly elastic springs. The ratio between contact pressure (P) at any given point, and settlement (y) produced by load application at that point, is named the coefficient of subgrade reaction, Ks:

$$K_s = \frac{P}{y} \tag{1}$$

In fact, in this model subsoil is replaced by fictitious springs whose stiffness equals to K_s. However, the simplifying assumptions, which this approach is based on, cause some approximations. One of the basic limitations of it lies in the fact that this model cannot transmit the shear stresses, which are derived from the lack of spring coupling. In addition, linear stress-strain behavior is assumed. The coefficient of subgrade reaction, K_s, identifies the characteristics of foundation supporting and has a dimension of force per length cubed.
Many researches like Biot (1937), Terzaghi (1955), Vesic (1961), and most recently Vallabhan (2000)... have investigated the effective factors and determination approaches of K_s. Geometry and dimensions of the foundation and soil layering are assigned to be the most important effective parameters on K_s. Generally, the value of subgrade modulus can be obtained in the following alternative approaches:
1- Plate load test, 2- Consolidation test, 3- Triaxial test, 4- CBR test
Many researchers have worked to develop a technique to evaluate the modulus of subgrade reaction, K_s. Terzaghi (1955) made some recommendations where he suggested values of K_s for 1×1 ft rigid slab placed on a soil medium; however, the implementation or procedure to compute a value of K_s for use in a larger slab was not specific. Biot (1937) solved the problem for an infinite beam with a concentrated load resting on a 3D elastic soil continuum. He found a correlation of the continuum elastic theory and Winkler model where