

An Experimental Study on the Effect of Relative Density on the Settlement Induced by TBM

Mehrdad Emami Tabrizi^{*}, Amin Abdoli Fazel, Salar Faraji
Civil Eng, Faculty, Sahand University of Technology, Tabriz

Received: 6 Nov 2016 Accepted: 17 July 2017

Extended Abstract

Paper pages (27-40)

Tunneling in soft grounds causes to changes in displacements and subsequently in-situ stresses around ground. These displacements may damage structural assets. Thus, estimating the magnitude and shape of settlement curve is necessary. There are several empirical and analytical methods for predicting settlement. For example, Peck's empirical method is well known method for predicting settlement due to tunneling. Tunneling process is done by imposing volume loss in tunnel. Then, soil displacement is measured by using image processing technique and that data is fitted to Gaussian curve. By conducting tests in loose and dense sands, it is concluded that by increasing relative density of the soil, the magnitude of settlement decreases and the settlement trough width will be increased. Also soil volume loss is not the same as the tunnel volume loss.

Introduction

Many researchers investigated settlement due to tunneling but there is a lack of research about the effect of relative density on settlement. Marshall et al. (2012) by conducting centrifuge tests in high density sandy soil, showed that settlement trough is affected by tunnel size, tunnel depth and tunnel volume loss. Zhou et al. (2014) by performing several tests in loose, medium and dense sand, examined the effect of relative density on settlement and showed that by decreasing the relative density the magnitude of settlement increases and settlement trough width will be decreased. In this paper by using 1g physical modeling (Figure 1) which is designed in Sahand

University of Technology, the effect of relative density on settlement has been studied.

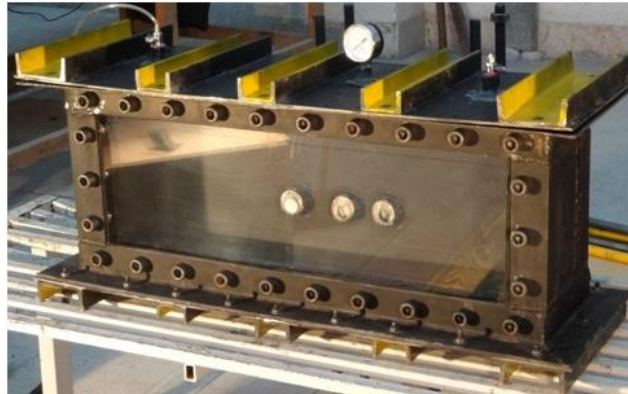


Figure 1. Physical model used in this study

Material and methods

Simulation of tunnel volume loss is carried out by using two different diameter tubes as a shield and lining (Figure 2), while pulling out the larger tube volume loss is imposed. Also by changing tube diameter different volume losses have been applied. Measuring of soil displacements is achieved by image processing technique. For this purpose, different photos are taken from the whole process of the test by digital camera and by using Geo PIV, settlement of ground is determined.

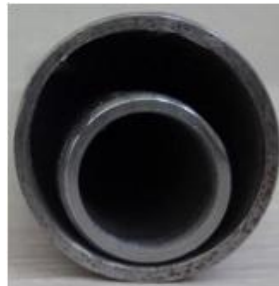


Figure 2. Tunnel simulation by using different tubes

Results and discussions

Experiments were conducted in loose and dense silica sands and the measured data have been fitted to Gaussian curve. The result showed that Peck equation fitted well to surface and sub-surface settlement data. As

shown in Figures 3 and 4, contour of displacement curve versus normalized tunnel depth and distance versus normalized tunnel diameter indicate that in dense sands most of the displacement occurred in the region which placed in distance of 1.25 times tunnel diameter and in loose sands in the-region of 0.6 times tunnel diameter. Thus, settlement trough width in loose sands is narrower. Also by measuring soil volume loss in loose and dense sands at different levels (Figure5) it is concluded that in loose sands due to less dilation, more volume loss is transferred to higher levels.

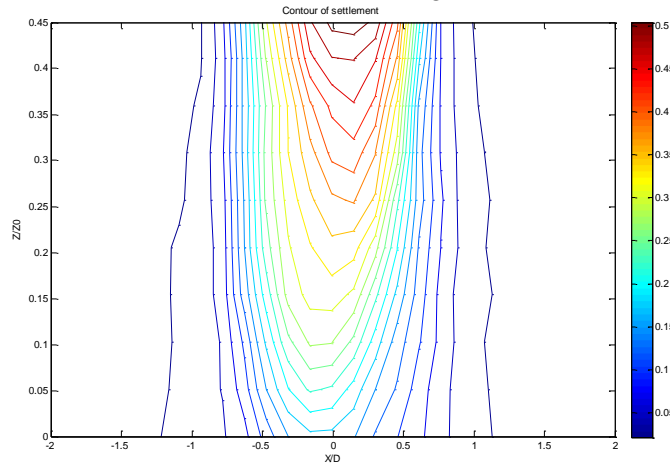


Figure 3. Contour of vertical displacement curve for dense sand

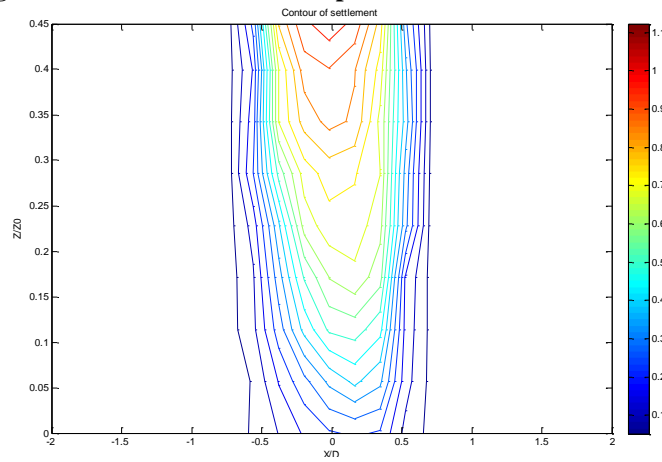


Figure 4. Contour of vertical displacement curve for loose sand

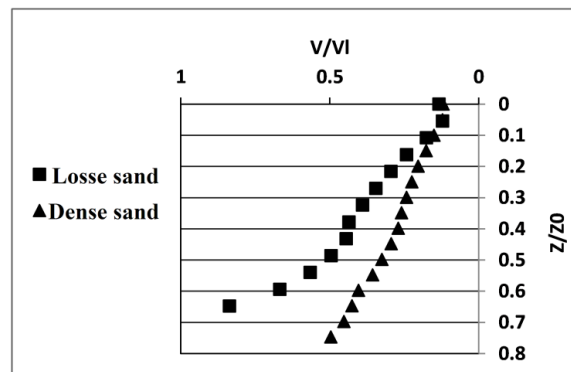


Figure 5. Comparison of soil volume loss at different depths for loose and dense sands

Conclusion

The following main conclusion can be drawn:

1. Gaussian curve predicts well surface and subsurface transverse settlements but selection of its parameters requires more accuracy that may result in inaccurate prediction.
2. Settlement curve in loose sands is narrower than dense sands.
3. Displacement and soil volume loss in loose sand are more than dense sand

Keywords: settlement, tunnel, physical modeling, sand, image processing

*Corresponding Author: m.emami@sut.ac.ir