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Procedia Structural Integrity 6 (2017) 101–108

Structural Integrity Procedia

www.elsevier.com/locate/procedia

XXVII International Conference “Mathematical and Computer Simulations in Mechanics of Solids and Structures”. FundamentalsofStaticandDynamicFracture (MCM 2017)

Methods of calculation of soil stress-strain distribution in sheet pile corset

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Abstract

Methodology of calculation of soil stress-strain distribution in sheet pile corset has been developed. Issues regarding calculation of closed pile sheeting which is used for stabilization of soil behavior in building structure footing have been addressed. Effect of sheet pile corset on stress and strain distribution in soil body has been analyzed. Soil body settlement and strain conditions (with / without corset) calculated by analytical approach and by finite elements methodhave been compared.

Peer-review under responsibility of the MCM 2017 organizers.

*Keywords:*calculation methods, sheet pile corset, stress-strain distribution, settlement, coefficient of friction.

In the construction process of new or re-construction of existing buildings it is necessary to consider the impact produced by new construction activities on the surrounding built-up environment. One of efficient ways to stabilize soil behavior in building structure footing is closed pile sheeting provided in the form of corset. Sheet pile corset is designed to localize the stress distribution area and thus reduce settlements occurring outside its boundaries. Therefore, such confining element allows reducing impact of facility under erection on existing buildings. While calculating the footing deformation with reference to strain conditions it is necessary to take into account variation of footing design and limit strains caused by soil behavior stabilization activitiesMangushev, R.A.and Nikiforova,N.S. (2017). Existing normative and technical documents contain no recommendations regarding calculation of stress-strain distribution in soils restrained by sheet pile corset; therefore such issue may be considered a hot topic.

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Peer-review under responsibility of the MCM 2017 organizers.
10.1016/j.prostr.2017.11.016

Scientific noveltyof this paper consists in (i) development of methods of stress-strain distribution calculation for soils with different characteristics, and (ii) implementation of specified methodology by analytical and numerical methods with the use of Plaxis 3D software Brinkgreve, R. B. J., Engin, E.,Swolfs, W. M. (2013). Validity of investigation resultsis determined by (i) application of well proven analytical dependencies and calculation software package, (ii) satisfactory repeatability of analytical and computational investigation results, (iii) matching of results obtained with (a) laboratory studies of other researchers and (b) field tests.
Factors generated by new construction activities carried out in restrained urban conditions were investigated by the following Russian scientists: Dalmatov, B.I., Ilyichev,V.A., Mangushev,R.A., Paramonov, V.N., Prokofiev, I.P., Savinov,A.V., Sokolovskiy,V.V., Sotnikov,S.N., Ulitskiy, V.M., Uflyand, Ya.S., Fadeyev, A.B., Tsytovich, N.A.,Shashkin, A.G. et al and the following foreign scientists:Terzaghi,K., Benz,T., Bowles, J.E., Brandl, H., Burghignoli, A., Fong,Fiona H.Y., Hazards, N., Katzenbach, R., Mao-cai Zhao, Pietruszczak, S., Pinto, A., Schanz,T., Schweiger, H.F. and other. Studies Alexeyev,S.I. and Khisamov, R.R. (2013); Orekhov, V.V. and Negahdar, H. (2013);Skibin, G.M. and Chizh,I.N. (2013);Chizh,I.N. (2013); Alexeyev, S.I. and Khisamov,R.R. (2014); Gurskiy,A.V. (2014); Svanov, T.S. andKhisamov,R.R. (2015) are listing results achieved by young scientists in the same lines of research.

This paper gives results of investigation of stress-strain distribution of soil enclosed in sheet pile corset (Fig.1). In order to describe mechanical behavior of soil we used Mohr-Coulomb model.

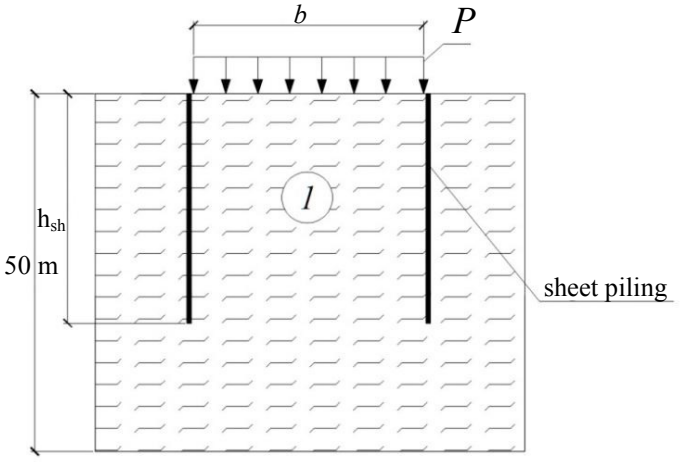

Fig. 1. Layout of soil footing enclosed in sheet pile corset:*p* – pressure on closed soil body surface, kPa; *1* – plastic clay; h_{sh} – sheet piling depth, m; *b* – width of foundation base, m.

In order to determine the value of soil body surface settlement we used additional stress definition formula:

$$\sigma_{vp} = \sigma_v - \sigma_{zg}, \tag{1}$$

where σ_v – vertical stresses occurring in soil body restrained by closed system composed of deep parallel walls,σ_{zg} – additional stresses in soil body free of sheet pile corset.

Stresses occurring inσ_v footing soil body surrounded by walls were determined using a formula from Coulomb's wedge theory obtained by Tsytovich,N.A. (1963):

$$\sigma_v = \frac{\gamma}{A} - \left[\frac{\gamma}{A} - \left(p + \frac{c}{\mathrm{tg}\phi}\right)\right] e^{-Az} - \frac{c}{\mathrm{tg}\phi}, \tag{2}$$