RESEARCH ARTICLE OPEN ACCESS

Influence of space of double row piles on soil arching effect

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Abstract
FLAC3d software, based on continuous theory, is used to analysis influence of space of double row piles on soil arching effect. The result shows that different from single row pile, double row piles will produce soil arching effect at front pile and rear pile severally, this phenomenon is called multiple soil arching effect; the residual load of front of front row pile will increase,the soil arch zone and the soil arching effect will decrease with the continuous increase of double row pile spacing.At the same time the soil arching effect of rear pile decreases, while the soil arching effect of front pile increases and finally the soil arching effect between front pile and rear pile will be equal.
Keyword: double row piles; the space of piles; FLAC3d; soil arching effect

I. Introduction

Anti-sliding pile in discrete construction to realize continuous retaining, soil arching effect plays an important role in realizing discrete to continuous. Terzaghi discovered the soil arching effect in 1943(Terzaghi, 1943). A lot of experiments, theoretical analysis, numerical simulation, and engineering practice show that: soil arching effect exit widely in anti-sliding pile retaining, and which is mainly composed of retaining mechanism(Ladanyi, 1969; Koutsabeloulis, 1989; Adachi, 2002; C-Y ChenE, 2005).

Although people have done detail system research on soil arching effect, but mainly on single row pile(Zhao Ming-hua, 2006; WANG W L,1974; Zhou Ying-hua,2006; JIA Hai-li, 2003; Yang Ming, 2007). The study of double row piles soil arching effect is still at the starting stage compared to single row pile. Most simply analyzes the mechanical effect of double row piles. However, there are still many issues worth exploring, the spacing of double row piles is one of them. The spacing of double row piles is directly related with double row piles retaining effect of the paly and the degree of engineering safety and economy, it has a very important guiding for design of double row piles. Based on this, the paper gives a detailed analysis on the effect of space of double row piles on soil arching effect, hopes to provide reference for related engineering.

II. Calculation model

This model uses the unit thickness of soil taken as analysis object. The picture shown in Figure 1. The cross-section of double row piles is square, length of c for double row piles cross-section: c=1m. the spacing of double row piles is L, L are 2c, 4c, 6c, 8c, 10c, 12c; the distance of front row and rear pile is d: d=3c, according to symmetry along the X axis take the interquartile range two pile center; in order to reduce boundary effect, but not affect the calculation accuracy, 10 times calculation area is taken where at front of front pile and rear of rear pile.

Soil material is homogenous soil, pile body use C30 concrete, the parameters are show in Table 1. Soil material and pile body use mohr-coulomb model and elastic model, interface between pile and soil use Goodman contact unit. In addition to loading boundary, the other boundary are arranged normal displacement constraint, piles full constraints. Landslide thrust q can be simulated by applying a uniform load in load boundary, q=10kpa.

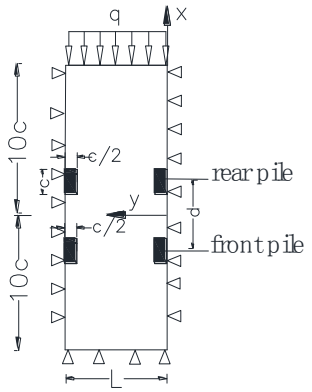


Figure 1 the top view of double-row pile calculation model

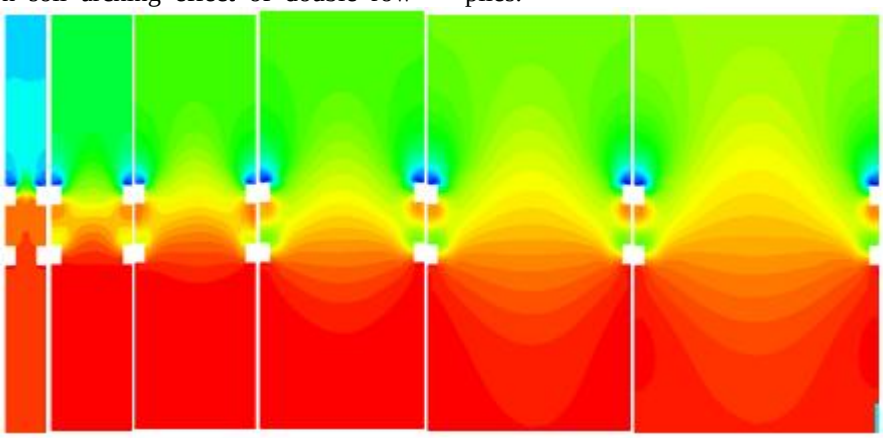
Table1. Material Calculation Parameters

	Elasticity /MPa	Poiss ion	Coh/ kPa	Frictio n/(º)	Dilatio n/(º)	Tension/ kpa
soil	5	0.3	40	30	0	20
pile	$3*10^4$	0.2	/	/	/	/

III. Influence of space of double row piles on soil arching effect

Keeping other model parameters constant, along changing the spacing of double row piles to analysis

its influence on soil arching effect of double row piles.



a b c d e f

a-2c ; b-4c ; c-6c ; d-8c ; e-10 ; f-12c

Figure 2 Nephogram of maximum principal stress of soil around piles

The Figure 2 shows nephogram of maximum principle stress of soil around double row piles under the spacing of double row piles L=2c、4c、6c、8c、10c、12c. From Figure 2 we can knows that the spacing of double row piles have a large influence on soil arching effect, when L=2c only in the rear row pile forms obvious soil arching, almost no soil arching forms at front row pile. When L=4c soil arching effect at front pile begins the formation, front row pile and rear row pile officially begins forming multiple soil arching effect. When L=6c, multiple soil arching effect of double row piles has been strengthened, and the front row pile begins to form weak anti-stress arching .When L=8c, the interface of soil arching effect between front row pile and rear row pile become fuzzy, and has the trend of convergence, and the anti-stress arching has been further enhanced, the enhance of anti-stress arching illustrates the outflow of soil from piles, indirect evidence of weakening of double row piles soil arching effect. When L>10c, font pile and rear pile have a trend of considered as a whole pile and forming a large single layer soil arching, while the anti-stress arching of front pile becomes very large, illustrating a large loss of soil from piles, and the soil arching effect is strongly weakened. In a word, with the increase the spacing of double row piles, the soil arching effect is weakening, and in L>6c front row begins to have anti-stress arching, that proving the soil arching effect has entered a rapid weakening period. So the pile spacing L should not be greater than 6c.

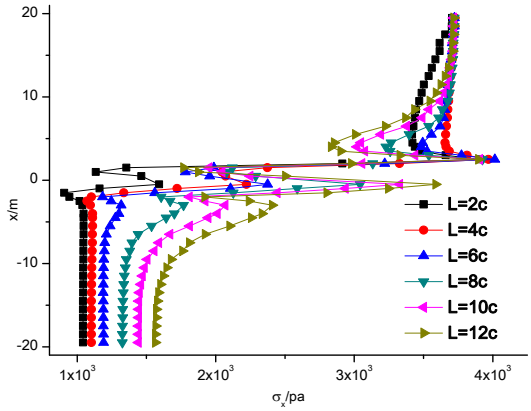


Figure 4 distribution curve of σ_y in axle wire

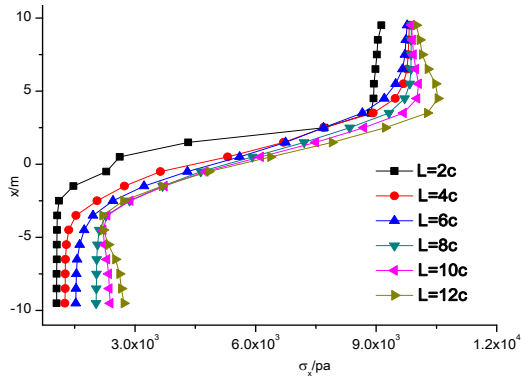
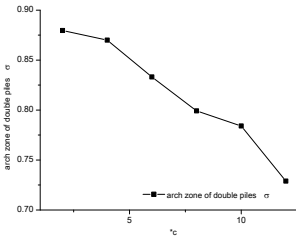


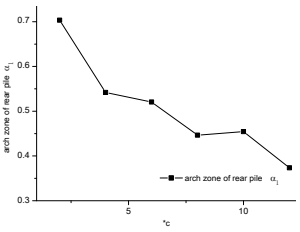
Figure 5 distribution curve of σ_xin axle wire

Figure 3 shows the distribution curve of σ_y under different spacing of double row piles. From Figure 3 we can know that with the increase of spacing of piles, the residual stressσ_y of font row pile in Y direction is strengthening, it suggests that double row piles can bear load is reducing, and the soil arching effect of double piles is weakening with the increase of the spacing of double row piles.

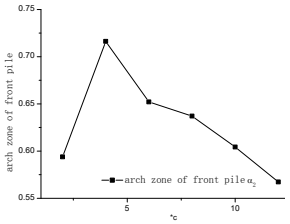
Figure 4 shows the distribution curve of σ_y under different spacing of double row piles. From Figure 4 we can know that with the increase of spacing of piles, the residual stress σ_xof font row pile in X direction is strengthening, it suggests that the soil arch zone of double row piles is reducing, and the soil arching effect of double piles is weakening with the increase of the spacing of double row piles.



a-arch zone of double row piles α



b-the arch zone of rear row pile α_1



c-the arch zone of front row pile α_2

Figure 5The soil arch zone α_iof different load

Figure 5 shows the arch zone of double row piles under different spacing of piles. As 5-a, 5-b shows that Both total arch zone of double row piles and arch zone of rear row pile approximate linear decrease with the increase of spacing of double row piles. The arch zone of front row pile rapid rise in L<4c, and reach a maximum in L=4c, and then with the continuous increase of piles spacing, the arch zone of front row pile also shows a linear decrease. So considering economy and play a role in optimization of front row pile and rear row pile, suggestions of double row piles spacing between 4c-6c.

IV. Conclusion

1 The soil arching effect will be produced first at rear pile second at front pile, and finally forms multiple soil arching effect with the increase of spacing of double row piles. When L>8c, the anti-stress arching will be produced obvious.

2 With the increase spacing of double row piles the residual stress of front of front row pile is enhancing, this make the arch zone of double row pile decrease.

3 Both total arch zone of double row piles and arch zone of rear row pile approximate linear decrease with the increase of spacing of double row piles. The arch zone of front row pile increase at first and in the tendency of decrease, and reach the peak at L=4c.

4 Based on above analysis, suggestions of double row piles spacing of L in 4c to 6c.

Reference

[1] TERZAGHI K. Theoretical soil mechanics[M]. NEW YORK, NY: john Wiley&sons,1943.

[2] LADANYI B, HOYAUX B.A study of the trap door problem in a granular mass[J]. Canadian Geotechnical Journal, 1969, 6(1):1-14.

[3] KOUTSABELOULIS N C, GRIFFITHS D V. Numerical modeling of the trap door problem[J]. Geotechnique,1989,39(1):77-89.

[4] ADCHI T,KIMURA M,TADA S. Analysis on the preventive mechanism of landslide stabilizing Piles[C]//Proc. 3rd International Symposium on Numerical Models in Geomechanices (NUMOG III). [S.I.]: Elsevier Applied Science,1989:691-698.

[5] MARTIN G R, CHEN C Y. Response of piles due to lateral slope movement[J]. Computers and Structure, 2005,83:588-598.

[6] Zhao Ming-hua, Chen Bing-chu, Liu Jian-hua. Analysis of the Spacing between Anti-slide Piles Considering Soil-Arch Effect, Journal of Central South Highway Engineering, 2006, 31 (2):1-3.

[7] WANG W L, YEN B C.Soil arching in slopes [J]. journal of the geotechnical engineering division ASCE,1974, 100(GT1):61-78.

[8] Zhou Ying-hua, Zhou De-pei, Feng Jun. Geometrically mechanical characters of soil arch between two adjacent laterally loaded piles and determination of suitable pile spacing, Rock and Soil Mechanics, 2006, 27(3):455-462.

[9] JIA Hai-li, WANG Cheng-hua, Li Jang-hong. Discussion on Some Issues in Theory of Soil Arch. JOURNA L OF SOUTHWEST JIAO TONG UNIVERSITY, 2003, 38(4): 398-403.

[10] Yang Ming, Yao Ling-kan, Wang Guang-jun. Study on effect of width and space of anti-slide piles on soil arching between piles, Chinese Journal of Geotechnical Engineering, 2007, 29(10):1477-1482.