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@ A B C D E F G H I J K $ L M I N O P 9 : Q R S T U V W X Y I J Z [\ ] ^ O _ J ` a 2 b c K $ d e f g h i I j k l m n o p $ n h f q r s t u v K w x y z { | } ~ • 2 K w x y z { K $ L M J & l K $ w J z v K g h J x y ~ 7 J } a g h J x y z { j & J Z j k 9 : 2 M U g h } 2 j & J O D 2 Y K l f l z { l g h t u $ w s 2 M m H I o K $ l v O P } 9 : j k L K $ J I N 9 : J D 2 I N O P K $ J % l J v [J L M }

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Theoretical solutions of soil-squeezing effect due to pile jacking considering geometrical characteristics of a pile

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Abstract: There are still many imperfect hypothesises or theoretical difficulties needed to be solved in the current energy-principle-based solutions of soil-squeezing effect due to pile jacking. The difficulties are as follows: boundary conditions of interface between pile and soil, continuity conditions for interface in stratified soil and different geometrical shapes of a pile, etc. Especially the geometrical shapes of pile have great influences on the severity rate of soil-squeezing effect and displacement mode of soil around the pile and geometrical characteristics of pile holes. The curvilinear equation of quartic polynomial is used to simulate the boundary of the pile hole to improve the presumption of previous research results which are not well suitable. Then, the soil squeezing model due to pile jacking is constructed, considering the effect of the final shape and displacement boundary of pile wall, the stress free ground surface, the finity of pile length and the non-linearity of soil materials. Finally, soil displacement, strain and stress solutions are obtained based on the variational principal. The present research method can be the basis for further theoretical studies on soil-squeezing problems, and the results are valuable for the engineering design and construction of pile foundation.

Key words: soil-squeezing effect due to pile jacking; space axis symmetry; boundary curve of pile hole; variational principal

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2 M E K $ I N m J \ k 2 m • Z v z { z \ z 2 J Z K J ' 2 J K & S n $ w 2 s 2 K J z { v V 2 ^ 9 : $ w K J ~ s v O P } [1] K J g h J 2

J s O P 2 O P 2 g h s V W X Y } Sagaseta[2-3] K K $ w z 2 k O $ w J z } E $ w 2 M

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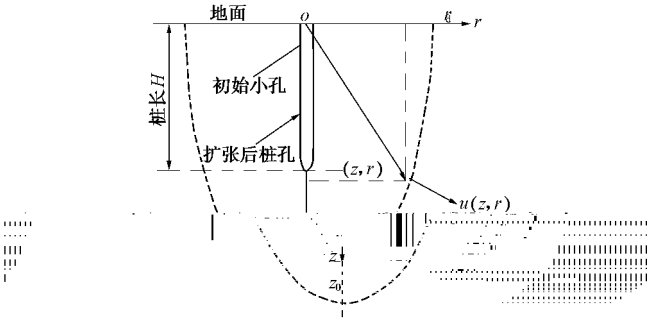
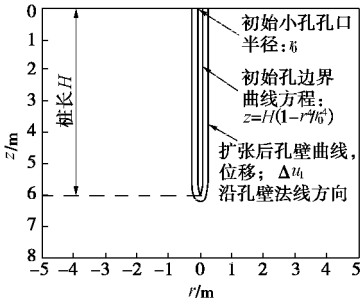


（a）曲线族及位移模式



（b）孔壁边界及其位移

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Fig. 2 Pile cavity expansion

1.2

m H I p m z J F ' * % & ' 2+ J A O 2 I N , - . J 2 / [J 0 1 E F \ E F T Y I 2 I N , T j X O P J 2 O P 2 3 4 E j X O } & J D & Z W - @

1 $ w s J q r 5 ' 4

2 $ w 6 Duncan-Chang }

7 8 / @ n 2 a ; G J K 2 Z [K $ w 9 : ~ ; < 2 ~ • t n 2 a J = J j & 2 } z_0 . z > a J w p S $z_0 \geq H$? @ q r Q g 2 j & C D ; < 9 : 9 : J • a 2 2 9 : 9 : J • a z,r A J (z_0 $z_0 \geq H$ 2 ; B (9 : 9 : z_0 C F J ~ b [6] @

$$f(z,r,z_0)=0 \quad 2 \qquad (2)$$

2 z_0 ~ C F }

1.1 D m v j & 1 v J z { v M y 2 E g h n 2 b } W n 2 b G 2 $\Delta u=r_0$ 2 j J } k j }

Q 2 ; G J ~ j &

$$f(z,r,z_0)=\frac{z_0 r^4}{(z_0-H+r_0)^4}-z_0+z=0 \quad 2 \qquad (3)$$

2z_0 ~ C F 2 $z_0=H$ g 2$z=H\left(1-\frac{r^4}{r_0^4}\right)$ 2 F 3 3 4 g h j & 1b }

[a } k j . z J G H 2 3 ; G J } k j I J

cos $\sqrt{\quad}$, sin $\sqrt{\quad}$

$$\left.\begin{aligned} e_r &= -\frac{\partial u_r}{\partial r}\,2\,e_q = -\frac{u_r}{r}\,2\,e_z = -\frac{\partial w}{\partial z}\,2 \\ g_{zr} &= \frac{\partial u_r}{\partial z} + \frac{\partial w}{\partial r}\,2 \end{aligned}\right\} \qquad (8)$$

2 u_r 2 w + v ? 2 e_r 2 e_q 2 e_z 2

2 $A(e_{ij})$ 12 G }

a 11 $r = y\,(z_0, q)\tan q$ b _ 14

15 }W n 3 G 2 15 • p m a f (z_0, q) X 2 b @ a (z_0, q) J K f p 13 X 2 z_0 J p m $H \sim \infty$ 2q J p m 0 ~ /2 2u_0 J p m $(0, \Delta u)$ }

$$\Pi = 2\int_H^{\infty}\int_0^{p/2}\int_0^{\Delta u}\left[\left(1+\tan^2 q\right)\times Dy\,\frac{\partial y}{\partial z_0}y\,\tan q\right]\mathrm{d}u_0\mathrm{d}q\,\mathrm{d}z_0 \quad (15)$$

2 $D = D\left(y, y\,\tan q, z_0, u_0, \bar{A}, \bar{B}\right)$ 4 $\bar{A} = \{A_1, A_2, \mathbf{L}, A_m\}, \bar{B} = \{B_1, B_2, \mathbf{L}, B_m\}$ }

= p m] 2 p m E 15 2 p m - ^ > F 2 p m 6 T g h A }

3

3.1

M 11 i 15 v 7 i 9 2 6 y [11] J K 6 2 6 | n 4 }

6 # M J C F W - @ K H=6 m 2 K + d=0.5 m 4

Q @ $r_0 = d/\left(2\sqrt{3}\right) = 0.14$ m } $ % C F | 1 }

Duncan-Chang s G " W

" H " 2 T n $ w J j I p 6

T O [2 & 6 J k l v m n H Q o p ' k $ v k $ J ^ c, j W V Z q p @ c=14 kPa 4 j =13.25 r }

E K $ w J $ s 5 E s k $ v t k $ u 2 [12] 2 6 y # M J & b C F @ v w M @ $R_f = 0.8$ 4 s G @ $E_i = Kp_a\left(s_3/p_a\right)^n$ 2 K = 200 2 $n = 0.5$ 4 w p z G $K_t = K_b p_a\left(s_3/p_a\right)^m$ 2 $K_b = 50$ 2 $m = 0.5$ }

1

Table 1 Soil parameters

$	s	U V	k l	m n H
n /m	G/Pa	M	/(kN m^{-3})	c/kPa	j /(r)
x 0 i 2	3.4 10^7			

6 " 2 | . K