Study on Grouting Thickness of Post Grouting Micro Steel Pipe Pile

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Abstract: As the high-speed and parallel processing features on FPGA, so it is widely used in high-speed information processing system. In this paper, the front-end data of X - ray energy spectrum is taken as processing object, high-speed data acquisition and processing methods based on the FPGA are proposed, which embodies the advantages of FPGA in the application of high speed information processing. The compensation measures in the electronic measurement system are also discussed in this paper.
Keywords: FPGA; High-speed Information Processing; X-ray energy spectrum; Electronic measurement system; Compensation measures

1. INTRODUCTION

The front-end data of X-ray energy spectrum is millivolt voltage pulse sequence, the pulse width of the sequence is microsecond level. But the amplitude and number of the pulse sequence contains the is sed system is FPGA as the control core. The data acquisition and processing system is composed of program control amplifier(PCA), A/D converter, FPGA unit, MCU unit and FIFO interface unit. The system block diagram is shown in figure 1.

Abstract: In the past, the post grouting micro steel pipe pile was used for building reinforcement and slope engineering. It was used for the first time for transmission lines. The previous research was mainly focused on the overall micro pile effect and the overall deformation coordination, but the grouting thickness of the post grouting micro steel pipe pile has not been studied. Steel pipe pile is studied and analyzed. After comparing the displacement and bending moment of the 10mm, 15mm and 20mm post grouting micro steel pipe pile under the action of horizontal and uplift force, the optimum grouting thickness is compared, and the influence factors of the optimum grouting thickness, the optimum grouting thickness and the relation of the grouting thickness are obtained.
Keywords: Grouting Thickness; Steel Pipe Pile; FPGA.

1. INTRODUCTION

At present, the research on micro steel pipe pile mainly concentrates on slope reinforcement and building reinforcement, The ultimate anti skid force of micro steel pipe piles is studied by finite element analysis by Ma Zhou Quan., Li Zhan and others studied the strengthening effect of micro steel pipe piles on existing buildings by testing the static load of steel pipe piles,Xiang Bo and others have obtained the data of pile body deformation, pile body strain, soil pressure and so on through the field loading limit failure test of the micro steel pipe pile pile structure, and analyzed and summarized the stress and deformation law of the steel pipe pile bearing horizontal load[1-3], Zong Zhongling proposed a micro static pressure steel pipe pile grouting pile forming technology, and analyzed the pile forming mechanism and characteristics[4], however, the optimal grouting thickness is not selected, nor is the foundation for transmission lines studied. In this paper, the finite element analysis of post grouting micro tubular pile is carried out by large general finite element softening Abauqs, The tower foundation in the upper part of the post grouting micro steel pipe pile foundation selects the basic force in 2B7-ZM1-27 in the typical design of the national grid, By changing the number of steel pipe pile and the thickness of grouting, the number of best micro steel pipe pile and the optimum grouting thickness are obtained, so as to achieve economic and reasonable safety.

2. MODEL SIZE

The model consists of 4 post grouting micro steel pipe piles with grouting thickness of 10mm, 15mm and 20mm, and 6 post grouting micro steel pipe piles with thickness of 10mm, 15mm and 20mm, and 8 post grouting micro steel pipe piles with thickness of 10mm, 15mm and 20mm, with a total of 9 models.

The model of the post grouting micro steel pipe pile is divided into the main column, the main column is 200m, the main column is connected with the bearing platform, the lower part of the cap is connected with

the micro steel pipe pile respectively. The micro steel pipe pile is filled with the steel pipe and external grouting in the exterior of the micro steel pipe pile through the inner post grouting, and the outer grouting thickness is respectively 10mm, 15mm and 2.0mm. The size of post grouting micro steel pipe pile is introduced below. The length and width of 4, 6 and 8 post grouting micro steel pipe piles are 1700mm, and the height is 500mm. The length and width of the main column are all 800mm and the height is 1200mm. The horizontal and vertical steel tube spacing between 4 micro steel pipe piles is 400mm, the length of the steel pipe is 6000mm, the diameter is 159mm, the wall thickness is 3mm, and the concrete layout is shown in Figure 1-3.

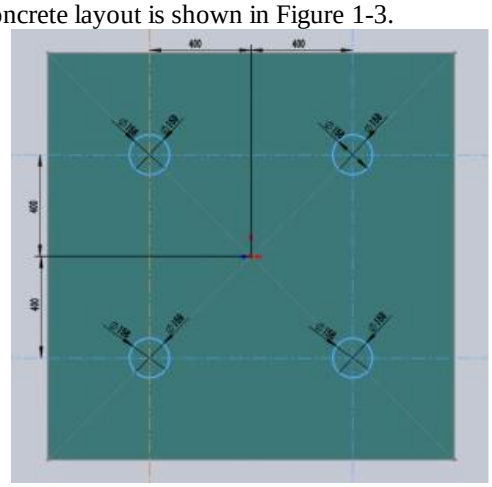

Figure 1 Layout of 4 micro steel pipe piles

The spacing of 6 steel pipe piles in the transverse arrangement of three steel pipes is 500mm. The spacing of two steel pipe piles in the longitudinal direction is 800mm, the length of the steel pipe is 159mm, the thickness of the wall is 3mm, and the concrete layout type is shown in Figure 2.

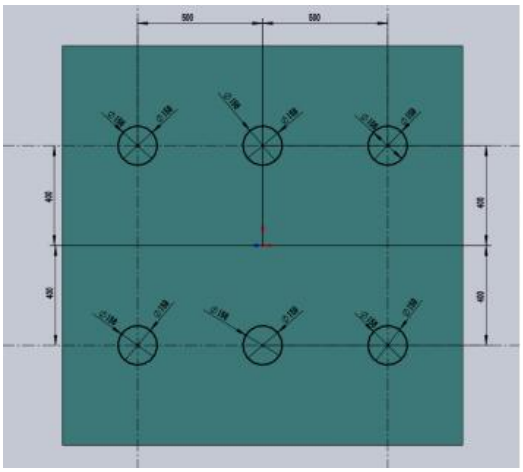

Figure 2 Layout of 6 micro steel pipe piles

The horizontal and vertical pipe spacing of 8 micro steel pipe piles is 500mm, the length of the steel pipe is 159mm, the wall thickness is 3mm, and the concrete layout is shown in the figure.

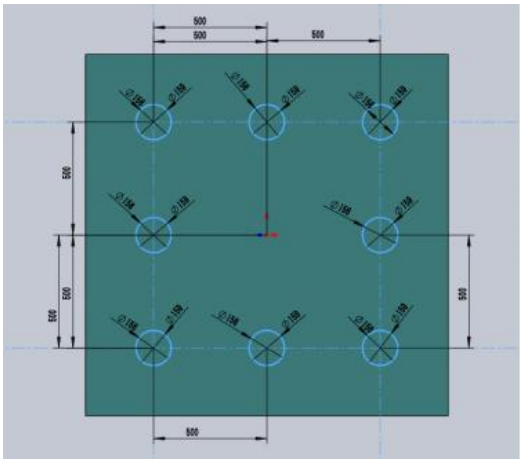

Figure 3 Layout of 8 micro steel pipe piles

3. MODEL SETTING OF POST GROUTING MICRO STEEL PIPE PILE

(1) The definition of the analysis step

The definition of step analysis in this model is divided into initial stress balance and static analysis. Because of the Mohr-Coulomb constitutive model, the others are asymmetric algorithms.

(2) The definition of contact

The definition of the model contact is first defined by the binding constraint between the internal grouting of steel pipe and the internal surface of the steel pipe, and the binding constraint between the external and internal grouting pipes is defined; The second is the definition of the contact of the external grouting, the cap, the main column and the soil. The main control surface is the post grouting, the cap and the main column, and the control surface is the soil. The key is the balance of crustal stress, and the measures adopted are friction free and normal hard contact in the step of in-situ stress analysis,the tangential friction between the applied load and the soil is 0.4 and normal contact is applied afterwards, tangential friction 0.6 and normal hard contact between steel pipe and grouting.

(3) Post grouting micro steel pipe pile and soil element selection, mesh generation and boundary load definition

The three-dimensional finite element model of post grouting micro steel pipe pile is C3D8 element, and the number of four post grouting micro steel pipe piles is 8644, the number of meshes of soil is 53572, and the total number of grid is 62216. The number of grids of six post grouting micro steel pipe piles is 22264, the number of grids of soil is 49424, and the total number of grids is 71688. The number of grids of eight post grouting micro steel pipe piles is 18448, the number of grids of soil is 142920, and the total number of grids is 161368. The internal grouting, steel pipe, external grouting, cap column and soil mesh are shown in the following figure. The internal

grouting, steel pipe, outer grouting, main column of the bearing platform and the soil mesh are divided into close contact at the contact area, and the grid is more combed outside the soil and the pile contact. The load exerts x horizontal force Tx=29000N at the outcrop of the main column, horizontal force Ty=24000N in Y direction, and uplift force T=257000N.

4. ANALYSIS OF MECHANICAL PROPERTIES

In order to analyze the bearing capacity of four pile micro steel pipe piles with different grouting thickness, the displacement and bending moment obtained by finite element analysis are analyzed. The lateral displacement of 4 micro steel pipe piles with different grouting thickness under the action of horizontal and uplift force shows that the maximum positive horizontal displacement of 4 micro steel pipe piles with 10mm grouting thickness is 0.977mm, the maximum negative horizontal displacement is 0.085mm, and the maximum positive horizontal displacement of 4 micro steel pipe piles with 15mm grouting thickness is 3.358mm and the maximum negative direction The maximum positive horizontal displacement of the 4 micro steel pipe piles with displacement 0.090mm and 20mm grouting thickness is 0.890mm and the maximum negative horizontal displacement is 0.3653mm. The maximum horizontal displacement and maximum negative horizontal displacement of different grouting thickness are shown in Table 1.

Table 1 Maximum horizontal displacement and maximum negative horizontal displacement of different grouting thickness

	Maximum positive horizontal displacement	Maximum negative horizontal displacement
10mm grouting thickness	0.977	0.085
15mm grouting thickness	3.358	0.090
20mm grouting thickness	0.890	0.3653

The maximum positive displacement and maximum negative displacement of different grouting thickness are drawn through table 1, as shown in Figure 4. When the grouting thickness is 10mm and 20mm, the maximum positive displacement of the micro steel pipe pile is smaller. When the grouting thickness is 15mm, the maximum positive displacement of the micro steel pipe pile is maximum. At this time the maximum positive displacement is approximately two parabolic lines with the grouting thickness, and the minimum displacement of the micro steel pipe pile when the grouting thickness is 10mm and 20mm is the smallest. The maximum negative displacement of the micro steel pipe pile increases with the increase of grouting thickness. For the maximum forward displacement, when the grouting thickness is 10mm-15mm, the maximum positive displacement of the micro steel pipe pile increases because the grouting is closer to the steel pipe, and the deformation of the grouting is larger than the steel tube. The positive lateral displacement of the micro steel pipe pile increases with the increase of the grouting thickness, while the grouting thickness is at 15-20mm, because the grouting outer layer is separated from the soil. It is relatively near and far away from the steel tube, and the grouting deformation is less than the deformation of the soil, which leads to the maximum positive displacement grouting of the micro steel pipe pile. For the maximum negative displacement, because the maximum negative displacement is opposite to the direction of the force, the micro steel pipe has little effect on the grouting, and the contact between the grouting and the soil is more important, and the maximum negative displacement value increases with the increase of the grouting thickness.

The above analysis shows that the maximum horizontal displacement and maximum negative horizontal displacement of the micro steel pipe pile are better when the grouting thickness is 10mm, so from the maximum horizontal displacement angle, the micro steel pipe pile with the grouting thickness of 10mm is preferred.

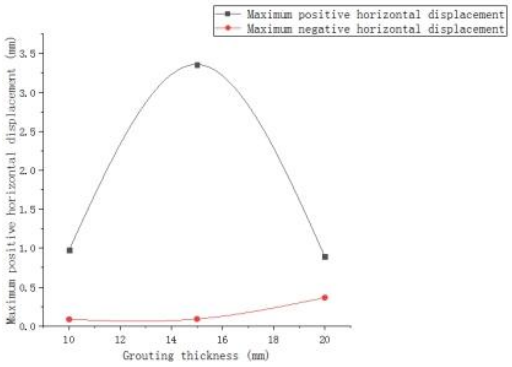

Figure 4 Maximum positive displacement and maximum negative displacement of different grouting thickness

According to the vertical displacement diagram above, the vertical displacement of 4 micro steel pipe piles with different grouting thickness under horizontal and uplift forces shows that the maximum displacement of 10mm grouting thickness is 4.676mm, the minimum displacement is 3.162mm, the maximum pulling displacement of 15mm grouting thickness is 4.808mm, the minimum displacement is 2.206mm, and the 20mm grouting is thick. The maximum displacement is 4.948mm and the minimum displacement is 3.513mm.

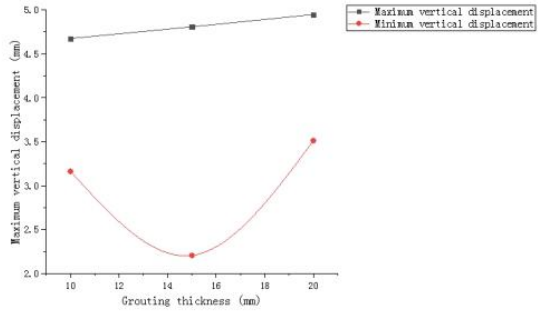

Figure 5 Maximum vertical displacement and minimum vertical displacement of different grouting thickness

Through figure 5, it can be seen that the maximum vertical displacement of the micro steel pipe pile under the effect of horizontal and uplift force between the 10mm-20mm grouting thickness is approximately linear with the grouting thickness and the maximum vertical displacement increases with the grouting thickness increasing, and the minimum vertical displacement decreases first and then increases with the grouting thickness. Through the vertical displacement comparison, the maximum vertical displacement of 10mm grouting is minimum, while the vertical displacement of 15mm grouting is more uniform, the maximum vertical displacement of 20mm grouting thickness is the largest and the total body position is not uniform. Therefore, from the vertical displacement, 10mm grouting thickness and 15mm grouting thickness are the best.

From the comparison of the horizontal displacement map 4 and the vertical displacement map 5, it can be seen that the maximum negative horizontal displacement is approximately symmetrical with the maximum vertical displacement, and the maximum positive horizontal displacement is approximately symmetrical with the minimum vertical displacement, and the maximum negative displacement can be seen from the maximum vertical displacement. There is a corresponding relationship between the large positive horizontal displacement and the minimum vertical displacement. Therefore, it can be concluded that the horizontal displacement of the post grouting micro steel pipe pile is related to the vertical displacement. In some degree, it can be seen that the horizontal displacement of the micro steel pipe pile can reflect its vertical displacement.

By drawing the data from the above table, we can draw the bending moment diagram of Mx in Z direction as shown in Figure 6.

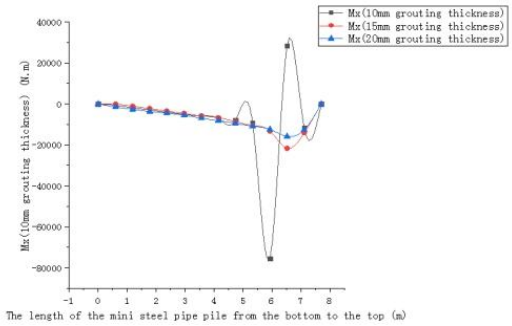

Figure 6 The bending moment diagram of Mx in the direction of Z

According to figure 6, under the condition of different grouting thickness, the bending moment of the micro steel pipe pile varies linearly with depth, and the bending moment decreases gradually with the depth increasing. The bending moment of the micro steel pipe pile with the thickness of the 10mm grouting is alternately alternately changed while the bending moment of the grouting thickness is 15mm and 20mm, and the bending moment is smaller. The alternation of positive and negative moments of moment is unfavorable to the force of the foundation, because the reinforcement measures can be considered to reduce the bending moment of the bending moment. From the analysis of this example, it is effective to reduce the change of the positive and negative alternating moment by proper thickness of the grouting at the junction of the micro pipe pile and the bearing platform.

Therefore, it can be concluded that the change of the grouting thickness change to the bending moment of the X direction is small, only the bending moment of the connection is changed, the connection can be eliminated by the reinforcement measures. So when the grouting thickness affects the foundation, the influence of the grouting thickness on the X direction can not be considered as the key point.

The bending moment diagram of the micro steel pipe pile along the Z direction and My is drawn through the data of the table above, as shown in Figure 7.

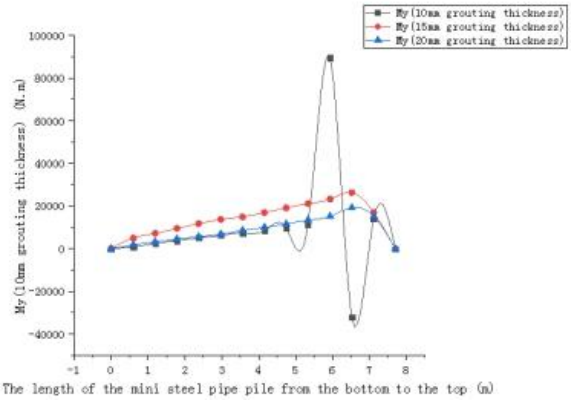

Figure 7 The bending moment diagram between the

Z direction and the My

It can be seen from Figure 7 that the My bending moment varies with the length of the micro steel pipe pile, and the My bending moment is approximately linear with the length of the micro steel pipe pile. The bending moment of the micro steel pipe pile in the grouting 10mm appears to fluctuate at the connecting place, and the bending moment of the grouting 15mm and the grouting 20mm is small, because My is similar to the above Mx. Reinforcement measures can be improved through increasing the grouting thickness at the joint. Therefore, the grouting thickness has little effect on the bending moment of the micro steel pipe pile, so it does not need to be considered as the main aspect.

The influence of bending moment on grouting thickness can be eliminated through the above analysis, and the influence of pipe diameter and wall thickness on grouting thickness is now considered. Through a large number of finite element numerical simulation and theoretical analysis, the steel pipe wall thickness is determined, and the optimum grouting thickness of different steel pipe diameter, as shown in Figure 4-6, is drawn as shown in Figure 8. In this analysis, the diameter of the steel pipe is greater than 40 times the thickness of the steel tube, otherwise the standard calculation conditions will not be satisfied.

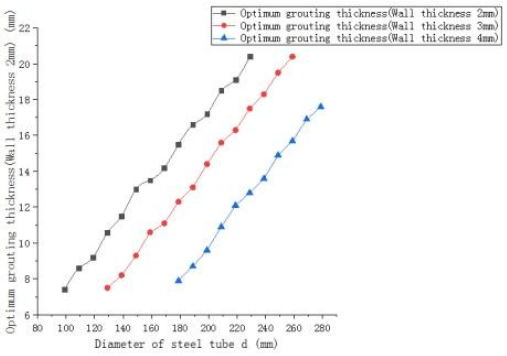

Figure 8 Variation of Optimal Grouting Thickness with Pipe Diameter for Different Wall Thicknesses

Through the above analysis, combined with the fitting curve to compile the program, Through the above analysis, combined with the fitting curve to compile the program, A=1/10， B=-0.628=-π/5 are finally obtained. are finally obtained.

The function relationship between the optimum grouting thickness R and the diameter of the steel pipe and the thickness of the steel tube is concluded. The derived function formula: $r=d/10-\pi r_0^2/5$. Through the analysis of the data, the applicability of the formula is verified in turn, and the accuracy of the optimum grouting thickness and the diameter of the steel tube and the thickness of the steel tube can be obtained by the verification.

5.CONCLUSION

This section analyzes the mechanical properties of 4 micro miniature steel pipe piles, and concludes the following conclusions:

(1) The optimal grouting thickness of micro steel pipe pile is determined by the relative distance between grouting and steel pipe and soil.

(2) In the calculation of the thickness of the grouting pile, the horizontal and vertical displacement of the steel pipe pile are mainly considered under the action of horizontal force and uplift force. The two aspects of the displacement are considered as the main aspects of the stress consideration.

(3) The effect of moment Mx and My on grouting thickness is small, so the optimum thickness of grouting can not be taken into consideration of bending moment Mx and My.

(4) Based on a large number of finite element numerical simulations, the numerical relationship between the grouting thickness r and the steel tube radius d and the steel tube wall thickness r_0 is summed up: $r=d/10-\pi r_0^2/5$, a theoretical basis is put forward for the optimal grouting thickness of post grouting micro steel pipe piles.

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