

The influence of vacuum preloading to existing road

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Abstract. The vacuum preloading will produce an effect of tension fracture on existing road. We have established the mechanical model of vacuum preloading in vacuum preloading zone by using FLAC3D software and analyze the influence of the supporting structure, which is the high pressure jet grouting pile. The influential area of vacuum preloading with the high pressure jet grouting pile of the expressway is 20 meters and the largest settlement is 2.24 centimeters. Obviously, the high pressure jet grouting pile can weaken the influence of vacuum preloading on the expressway obviously more.

1. Introduction

On the one hand, as urban land becomes less. On the other hand, the construction capability of reclamation is continuously improved, so it must contribute to the development of foundation treatment technology, however the impact of the soft foundation treatment on existing structure (construction) will be an important problem which we must consider in the process of soft foundation reinforcement in the future. This problem will be connected to the people's lives and social stability.

Vacuum preloading is an important solution in treating soft foundation^[1], according to the requirement in 《Building foundation treatment norms》(JGJ79-2002)^[2] and on the basis of abiding the basic principles of geotechnical^[3], realization of finite element simulation of vacuum preloading process, and to carry out the safety evaluation of supporting structure^[4]. It is a good reference for the similar project in the future and has a certain practical significance.

2. Project overview

There is a vacuum preloading area close to an expressway which has a large traffic flow. The minimum distance between the side boundary of vacuum preloading area and pipeline corridors group of expressway is 7 meters. There is surface backfill soil in vacuum preloading area, containing part of the stone, and burial depth is pretty large, and it is hard to conduct board construction. Before board construction we need to conduct excavation and filling in the vacuum preloading area, some of areas need to fill until 0 meters high. There exists some influence of excavation and filling on pipeline corridors group. So, before excavation and filling we need to use jet grouting pile for supporting treatment, and consider adopting cast-in-place pile and the jet grouting pile for supporting treatment. Adopting pouring pile + jet grouting pile for support treatment in the east side where a big depth of excavation and filling in there. Continuous wall formed from high pressure jet grouting pile may become the vacuum preloading sealing wall.



Expressway adopts CFG pile to deal with foundation. The red line of the road is treated with a square interval of 2.0m of CFG pile; the pipeline corridors are treated with a regular triangular interval of 2.0m of CFG pile. The CFG pile adopts commercial concrete with diameter of 40 centimeters and strength grade of C15. The design height of the pile is 2.0m. Cushion adopts rubble with thickness of 50 centimeters. All the CFG pile punch silt and punch into the holding layer is not less than 1.0m.

The conduct edge of vacuum preloading area from expressway is only 7m. It is necessary to verify the reasonableness of isolation protection measures which between the vacuum preloading area and expressway, and guarantee whether the effect of vacuum preloading on the expressway is small enough and will not have too much damage to the expressway.

3. Geological prospecting data and soft foundation reinforcement scheme

Processing width of vacuum preloading area is 25 meters. Considering the most unfavorable situation, select the section with the largest thickness of the soft soil as the calculated section; calculate the soil parameters of the section as shown in Table 1.

Table 1 Calculation of soil parameters table

Name of the soil layer	Depth (m)	Density (g/cm ³)	Modulus of compressibility (MPa)	Internal bunching cohesion (kPa)	Angle of internal friction (°)	Coefficient of permeability (cm/s)	
						Vertical	Level
1-1Plain	2.16	1.72	2.06	7	16.8	2.71E-05	2.95E-05
2-1Silt	8	1.62	1.84	6.7	16.2	3.44E-07	4.56E-07
2-2Silt	2	1.6	1.72	6.7	16.2	2.90E-07	4.37E-07
3Silt	7.5	1.62	1.64	7	16	2.56E-07	3.38E-07
6-1 clay	4.3	1.71	2.29	8.8	16.5	7.21E-08	7.15E-08

The preliminary design scheme uses the vacuum preloading to deal with the foundation; the depth of drain board at the computation cross-sections is 17m, plum-shaped arrangement, and spacing is 1 meter.

4. Numerical analysis model

According to geological data in Table 1, using large-scale commercial software FLAC3D established mechanical model as shown in Figure 1.

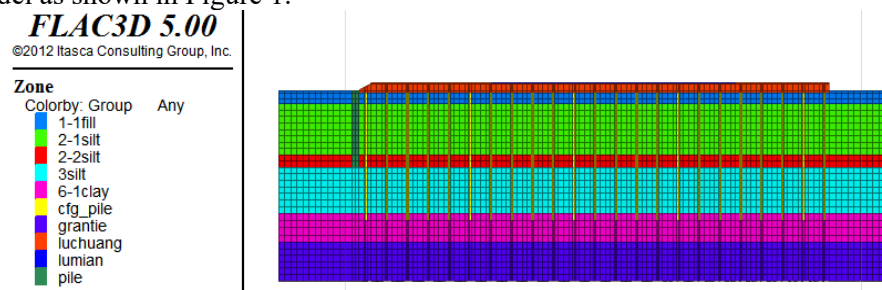


Figure 1 Mechanics model of Vacuum preloading area

In the model, weathered granite is considered to impervious elastomer, and other soils are considered to Mohr-Coulomb materials. Vacuum preloading area in the vacuum pressure which is 85kPa, the time of calculating the preload requires 120 days. The vacuum preloading area of plastic drainage board adopted the method of Chai Jinchun's to equivalent calculating^[5].

After applying the vacuum preload, the vacuum under the film reaches 80kpa in few days, then calculating the vacuum preloading loading time, planned to load 120 days, vacuum preloading depends the measured settlement value in the later period to calculate the consolidation degree,

residual settlement, forecast settlement trend, and the design institutions to determine the specific preload unloading time.

5. Calculation and Analysis the Model of High Pressure Jet Grouting Pile Retaining Structure

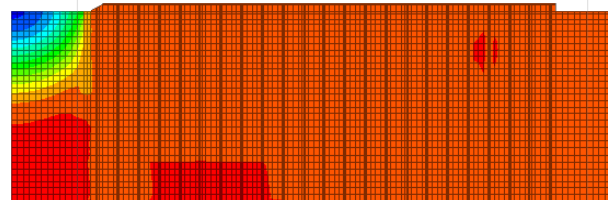
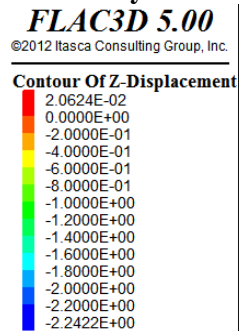


Figure 2 Settlement cloud map

Through the analysis the model of the high pressure jet grouting pile as the retaining structure, we get the treatment results of vacuum preloading area after 120d, Figure 2 for is the sedimentation cloud after calculation.

Figure 2 shows that the center subsidence of the vacuum preloading area is the largest, and the settlement in the direction of the surrounding and deep foundation gradually decreases and the maximum settlement of the model is 2.24 m

Through the finite element simulation, it can be seen that the vacuum pressure is transferred in the vacuum preloading area, and the pore pressure stratification is reasonable. There is a clear boundary between the vacuum preloading area and the non - vacuum preloading area, which indicates that the high pressure jet grouting pile plays a sealing role. The maximum lateral displacement occurs near the high pressure jet grouting pile in the vacuum preloading area, which reached 0.53m. Expressway CFG pile has a tendency to bending to vacuum preloading area.

The outer edge of the high pressure jet grouting pile is refers to one side edge of expressway. It's shown that lateral displacement of foundation surface on one side of expressway, and takes the movement of retaining wall as positive. If define the range of influence is the area of 5cm lateral displacement of the expressway pile foundation, the range of influence is over 50m in this working condition.

According to the simulation results, it is found that the farther away from the high pressure jet grouting pile supporting wall, the smaller the surface subsidence, the foundation settlement of supporting wall is only about 7cm, the closer expressway the smaller settlement, indicating that the effect of vacuum preloading on the settlement of CFG pile foundation is small. The depth variation curve of the deep lateral displacement at different distances from the high pressure jet grouting pile is similar.

The influence of the vacuum preloading area foundation treatment on the expressway is 20m, the maximum lateral displacement of the CFG pile adjacent to vacuum area is 8.3cm on the expressway pipeline corridors group, and the maximum lateral displacement of the CFG pile is 5.3cm in the expressway away from the vacuum area 15m.

6. Conclusion

When the supporting structure is the high pressure jet grouting pile, the influence of the vacuum preloading area foundation treatment on the expressway is 20m, the maximum lateral displacement of the CFG pile adjacent to vacuum area is 8.3cm on the expressway pipeline corridors group, and the maximum lateral displacement of the CFG pile is 5.3cm in the expressway away from the vacuum area 15m.

High-pressure jet grouting pile supporting wall can weaken the vacuum preloading on the adverse effects of the expressway.

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