Impact of the excavation and dewatering of the foundation pit on the stability of the plug-in steel cylinder

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Abstract. The plug-in steel cylinders performance well in forming the bulkhead of the man-made island. In the late stage of the man-made island construct period, the excavation and dewatering treatment will be conducted in the island, and these treatments may influence the stabilities of the steel cylinders. This paper analyzed the impact of the excavation and dewatering treatment on the steel cylinder based on an engineering case with numerical simulation method. And corresponding engineering treatments for preventing the local instability of the cylinders are proposed.

1. Introduction
The plug-in steel cylinders are widely used in the construction of the man-made island, which belongs in the island-bridge-tunnel system for the communication of the bay area [1]. In the late stage of the construction period, the excavation and dewatering of the foundation pit is carried out in the man-made island, leading to the negative pore pressure and the resulting underground seepage. The underground seepage causes the deformation of the foundation soil and threatens the stability of the plug-in steel cylinder, especially for the plug-in steel cylinder laid on a soil layer with high permeability [2] [3].

This paper analyzed the stability of a plug-in steel cylinder from an engineering case located in the Zhu-Jiang River, and the corresponding engineering treatment for mitigating the instability risk of the cylinder was proposed.

2. The description of the engineering case
The engineering case is a part of the Shen-Zhong Tunnel engineering project. The engineering area locates at the downstream of the Zhu-Jiang River (as shown in Figure 1). The plug-in steel cylinders, which is pipe-shape in horizontal direction with the outer diameter of 28 m and the wall thickness of 19 mm, are used for building the bulkhead of the man-made island. The elevations of the tops of the cylinders are +3.5 m, and the elevations of the bottoms of the cylinders ranges from -31.5 m to -36.0 m. The weights of cylinders are 583~653 tones. The standard space between cylinders is 2 m, and the arch-shape connectors are welded to fill this gap.
3. The description of the engineering case

3.1. The deformation of steel cylinder without mitigation treatment
The exceed pore pressure of the foundation, the lateral and vertical deformation of the steel cylinder, and the stability of the cylinder are shown in Figure 2, 3, 4, and 5, respectively.

As it is shown from Figure 2 to Figure 5, the maximum exceed pore pressure reaches to 999.8 kPa after the excavation and dewatering treatment. Due to the impact of the underground seepage, the maximum lateral displacement is 56 cm, and the vertical settlement is 1.23 m, causing the safety factor of the steel cylinder falling down to 1.05.
3.2. The deformation of steel cylinder after deploying the mitigation treatment
The high-pressure jet grouting piles are installed to form a sealing curtain subsequently. The exceed pore pressure of the foundation, the lateral and vertical deformation of the steel cylinder, and the stability of the cylinder after piling are shown in Figure 6, 7, 8, and 9, respectively.
As it is shown from Figure 6 to Figure 7, the maximum exceed pore pressure falls to 99.78 kPa after piling. And the maximum lateral displacement is 24.1 cm, and the vertical settlement is 55 cm, causing the safety factor of the steel cylinder rising to 2.266.

4. Conclusion
This paper analyzed the impact of the excavation and dewatering treatment in the man-made island on the stability of the plug-in steel cylinder. The main conclusions are as followed.

(1) The exceed pore pressure, lateral movement, and vertical settlement rise heavily after the deploying of the excavation and dewatering treatment, and the safety factor for assessing the stability of cylinder falls seriously. The mitigation treatment must be deployed to remain the stable of cylinder.

(2) The sealing curtain made up by high-pressure jet grouting piles performances well by almost stopping the underground seepage, and the exceed pore pressure, lateral movement, and vertical settlement reduces greatly. As a consequence, the safety factor goes up to 2.266 after piling.

References
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