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Emerging Technologies in Tunnel Engineering, Modeling, Design, Construction, Repair, and Rehabilitation

Edited by

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Preface

This Geotechnical Special Publication contains 34 peer-reviewed technical papers presented at the 4th GeoChina International Conference: *Sustainable Civil Infrastructures: Innovative Technologies for Severe Weathers and Climate Changes*, which took place in Shandong, China, from July 25 to 27, 2016. This proceeding examines topics such as:

- Tunnel Management and Inventory, Monitoring and Settlement Control
- Emerging Technologies, Lining Design & Precast Segment Advances
- Innovation in Tunneling Design, Construction, Repair, Rehabilitation
- Fire & Life Safety, Vulnerability & Security
- Tunneling in Soft Ground, Ground Conditioning and Modification
- Advanced prediction technology of tunnel construction geology
- Deep excavations and urban tunneling

This publication should be valuable to geotechnical engineering professors and students, as well as geotechnical engineers and professionals.

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Contents

A Jet-Grouted Wall in Mitigating Tunnelling Effects on Adjacent Structures

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Abstract: Technical measures, such as underground partition wall, could sever as recourse to mitigate the ground movements induced by excavation. In this paper field monitoring and numerical analysis were used to examine the performance of underground jet-grouted partition wall in mitigating the effects of shield tunnel construction on existing pier of Xin-Zhong-Road viaduct in the project of Changsha Subway Line 1 in China. The performance of the jet-grouted partition wall was calibrated by the reasonable agreement found between the observed field measurements and the numerical results. Underground jet-grouted-column partition wall was testified to serve as an effective measure in ground movement control given the need of tunnelling nearby piled structures.

1 INTRODUCTION

Tunnelling in urban areas may cause damage to buildings founded adjacent. Underground partition wall installed between the buildings and the tunnel was expected to cut off the displacement induced by tunnelling so that the nearby buildings can be protected. Some researches have been carried out to study the mechanism of underground partition wall in reducing the damage impact of tunnelling to adjacent structures.

Harris et al. (1994) presented that the compensation grouting could effectively reduce the ground settlement and nearby building distortion. Bilotta and Taylor (2005) carried out centrifuge tests to study how the diaphragm wall reduces the tunnelling induced movements at the two side of the wall. Kirsch and Piazzi (2009) also identified the influential parameters of bored pile wall to protect sensitive buildings from settlement resulting from tunnelling using numerical simulations. They concluded fully mobilized friction between soil and wall leads to no significant reduction of settlement on the far side of the wall. Bilotta (2008) performed a series of centrifuge tests and

numerical analyses to investigate the effects of a diaphragm wall. They found length and thickness of the wall, and the roughness of the soil-wall interface, the length of the wall plays the main role in the effectiveness of reducing ground movements. Wu et al. (2012) studied the pile wall in controlling the tunnelling effects on the nearby wood piles of a church through a numerical analysis. Zou and Xu (2013) carried out three-dimensional numerical simulation to investigate the mitigation effects of the separation pile and diaphragm wall to tunnel induced ground movements, considering the effects of soil at small strain stiffness.

In this paper, the performance of underground jet-grouted partition wall in mitigating the effects of shield tunnel construction on existing pier of Xin-Zhong road viaduct in the project of Changsha Subway Line 1 was examined based on field measurements and numerical analysis. The performance of the jet-grouted partition wall in reducing the tunnelling influence on the adjacent pier is illustrated by a comparison between the field measurement and numerical results. The effectiveness of using jet-grouted underground partition wall in reducing tunnelling induced displacement was testified and discussed.

2 PROJECT OVERVIEW

2.1 Construction techniques

The tunnelling project referred to is located closely on the east side of L-off-ramp of Xinzhong-road viaduct in the project of Changsha Subway Line 1, as shown in Figure 1. The construction consists of two parallel tunnels. The two tunnels are circular and their axes are 21.5 m below the ground surface level while there is a central line separation of 17.3 m between them. The studied tunnel section is about 155 m long from the distance mark DK24+245 to DK24+400. Composite EPB shield tunnel boring machine of 6.25 m diameter was used to construct the tunnels. Each construction cycle involved an excavation in advance of the shield 1.5 m to install the segment lining before shoving the shield forward. The precast concrete segments were each 0.3 m thick. Each segment ring was formed from 6 precast concrete segments and has an internal diameter of 5.4 m.

Six piers of the L-off-ramp of Xinzhong Road viaduct are situated on the east side of the east bound tunnel, and their marks vary from L01# to L06#. Each pier was founded by four piles except L01# was supported by a single pile. The distances from the piles to the tunnel central line vary between 6.7 to 9.9 m, which was no more than 1.5 times of the tunnel diameter. The pier L04# is located at DK24+330 founded by four friction-cum-end bearing piles. Each pile has a diameter of 1.2 m enlarging to 1.8 m at the end and is separated by a spacing of 3 m to the other piles. The distance of the nearest pile to the tunnel profile was 6.9 m.

In order to minimize the tunnelling effect on the pier, three rows of jet-grouted piles were installed to form a at least 4 m wide underground partition wall to protect the pier from tunnelling induced deformation. The jet-grouted columns have a diameter of 0.8 m while their axis spacing is 0.5 m. That means there is always about 0.3 m jet-grouted