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## Application of ground penetrating radar (GPR) in look-ahead detection of slurry balance shield machine

Weiwei Duan<sup>1</sup>, Xiongyao Xie<sup>1</sup>, Yong Yang<sup>2</sup>, Kun Zeng<sup>1</sup>, Huiming Wu<sup>2</sup>, Li Zeng<sup>1</sup>, and Kang Li<sup>1</sup>

<sup>1</sup>Department of Geotechnical Engineering, College of Civil Engineering, Tongji University, Shanghai 200092, the People's Republic of China (2673937227@qq.com)

<sup>2</sup>Shanghai Tunnel Corporation, Shanghai, the People's Republic of China

The shield machine has become the mainstream of subway tunnels construction because of its safety and efficiency. But with the continuous development of urban construction, the environment of subway tunnel construction is becoming more and more complex. In the process of shield tunnels construction in southern cities of China, slurry balance shield machines often encounter various obstacles, such as large diameter boulders and concrete pile foundations, which result in accidents of shield machine sticking. Therefore, it is necessary to quickly and accurately detect the distribution of obstacles in front of shield excavation face in advance so that operators can in time take measures to reduce the occurrence of such accidents. Ground penetrating radar (GPR) is a method widely used in engineering geological exploration. It has advantages of small working space, high efficiency and no damage compared with other detecting methods. When the GPR antenna is mounted on the cutter head of the shield machine, the obstacles in the stratum ahead of the shield machine can be detected in real time. Under this condition the GPR antenna's real work mode is that it will rotate with the cutter head to form a circumferential survey line. Based on Finite-Difference-Time-Domain-Method (FDTD), authors use the common numerical simulation software (GPRMAX) to make simulations of GPR circumferential detection under the antenna array rotating with the cutter head, which verifies the theoretical feasibility of this method. By simulating radar emission and reflection pattern of electromagnetic wave, we study the propagation pattern of the reflect wave after encountering the obstacles and conclude the image pattern to establish the foundation for image recognition of obstacles. Due to the radar wave being susceptible to electromagnetic interference, GPR is still lack of engineering practice in shield advanced detection. To reduce the interference of the surrounding metal cutter head, a new strip radar antenna with a shielding shutter is designed to improve the directivity of electromagnetic wave propagation. Several antennas are fixed at several slurry openings of the cutter head of slurry balance shield machine to form radar antenna array and improve detection efficiency and accuracy.