Impact Analysis of Foundation Pit Engineering on Structural Safety of Adjacent Shallow-Buried Tunnels (Postprint)

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Abstract

During the construction of deep foundation pits adjacent to existing subway structures, due to the complexity of engineering geological conditions and boundary conditions, theoretical analysis can hardly accurately calculate the deformation and internal force variations of adjacent subway structures; ensuring the safety of subway structures is an issue that must be considered. The Guangzhou Design City Phase II Jiangxia Reserved Land Project is adjacent to an open-cut subway section with a double-bore rectangular frame structure as its main body, and the affected section has a burial depth of approximately 5.3–8.0 m. Based on the design and construction data of this project and the adjacent subway structure, as well as their relative positional relationship, this paper establishes a three-dimensional finite element model to simulate construction procedures including foundation pit retaining structure construction, foundation pit excavation, support system installation, basement structure construction, support removal, and foundation pit backfilling, and calculates the deformation and internal force variations of the adjacent shallow-buried subway tunnel structure under various working conditions. Considering the influence of foundation pit dewatering and adverse geological conditions, a two-dimensional plane strain model is established to analyze the potential hazards to subway structure safety posed by water level decline and karst cave treatment. According to numerical simulation results and measured data from similar projects, this paper analyzes the impacts of different factors and construction procedures on subway structure safety, discusses measures to reduce deformation of subway structures caused by foundation pit construction, and proposes relevant recommendations regarding design, monitoring, and construction for this project, providing certain references for risk control in this project and similar projects.

Full Text

Analysis of the Influence of Foundation Pit Engineering on the Safety of Adjacent Shallow Metro Structures

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Abstract

During deep foundation pit construction adjacent to existing metro structures, the complexity of engineering geological conditions and boundary conditions makes theoretical analysis inadequate for accurately calculating deformation and internal force variations in adjacent metro structures. Ensuring the safety of these metro structures is therefore a critical issue that must be addressed.

The Guangzhou Design Capital Phase II Jiangxia Reserved Land Project involves an adjacent metro structure that comprises an open-cut section with a double-box rectangular frame structure, with the affected section buried at a depth of approximately 5.3–8.0 m. Based on the project's design and construction documentation, as well as the relative spatial relationship with the adjacent metro structure, this study establishes a three-dimensional finite element model to simulate the construction sequence, including retaining structure installation, pit excavation, support system construction, basement structure construction, support removal, and pit backfilling. The model calculates the deformation and internal force changes in the adjacent shallow metro tunnel structure under various working conditions.

Considering the effects of foundation pit dewatering and adverse geological conditions, a two-dimensional plane strain model is also developed to analyze potential hazards to metro structure safety arising from water level decline and karst cave treatment. Drawing upon numerical simulation results and field measurement data from similar projects, this paper examines the influence of different factors and construction procedures on metro structure safety, discusses measures to mitigate deformation induced by foundation pit construction, and proposes specific recommendations for design, monitoring, and construction relevant to this project. The findings provide valuable references for risk control in this and similar engineering endeavors.

Keywords: foundation pit engineering; shallow tunnel; numerical simulation analysis; metro structure deformation

Note: Figure translations are in progress. See original paper for figures.