Real-Time Monitoring of Adjacent Construction Impacts on Shield Tunnels Based on Dynamic Responses of Operating Metro Systems: Postprint

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Date: 2025-09-02T00:00:00+00:00

Abstract

This paper proposes a real-time sensing method based on the dynamic response of operating metro systems to monitor the effects of adjacent construction activities on shield tunnels. The effectiveness of this method is validated through a combination of numerical simulation and model testing. The simulation assesses the impacts of nearby excavation and pile driving operations on both tunnel structure and metro response. Subsequently, model tests are conducted with pile driving as a representative construction scenario. Analysis of metro acceleration responses at different stages reveals distinct instantaneous peaks and transient fluctuations. The corresponding short-time Fourier transform (STFT) spectrograms exhibit concentrated energy in high-frequency bands, thereby enabling estimation of the location and intensity of construction disturbances. This study establishes a framework for real-time detection of external disturbances and potential intrusions using operational metro data, providing technical support for safety monitoring in the vicinity of tunnels.

Full Text

Real-Time Monitoring of Adjacent Construction Effects on Shield Tunnels via Dynamic Response of Operating Metro Systems

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Abstract

This paper proposes a real-time sensing method based on the dynamic response of operating metro systems to monitor the effects of adjacent construction activ-

ities on shield tunnels. The effectiveness of this method is validated through a combination of numerical simulation and model testing. The simulations evaluate the impacts of nearby excavation and pile driving operations on both tunnel structure and metro response. Subsequently, model tests were conducted with pile driving as a representative construction scenario. Analyses of metro acceleration responses at different stages reveal distinct instantaneous peaks and transient fluctuations. The corresponding short-time Fourier transform (STFT) spectrograms show concentrated energy in high-frequency bands, enabling estimation of the location and intensity of construction disturbances. This study establishes a framework for real-time detection of external disturbances and potential intrusions using operational metro data, providing technical support for safety monitoring around tunnels.

Keywords: Shield tunnel; Adjacent construction; Dynamic response; Short-time Fourier transform

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