Intelligent analysis method for the global vertical displacement field of foundation pits in dense karst cave areas postprint

Authors: Jin Liao, Chunxiu Lin, Chunhui Lan, Yongtao Wu, Zhen Liu, Cuiying Zhou

Date: 2025-07-17T00:00:00+00:00

Abstract

Prior research on excavation in dense karst cave foundation pits has primarily concentrated on evaluating the localized spatio-temporal influence and isolated geological factors. Nonetheless, this approach oversimplifies modeling conditions, thereby limiting its ability to provide a comprehensive understanding of the vertical displacement field. Consequently, this oversimplification can inflate the safety factor and increase project costs. Therefore, we propose a feedforward neural network (FNN), updated with the loop nested optimal iterative method (LNOIM), which incorporates the spatiotemporal characteristics of monitoring points and geological factors to analyze the engineering sensitivity of karst caves. Ultimately, the global foundation pit vertical displacement field was obtained. Our method has been demonstrated to be effective in a foundation pit in South China ((P value) $P > 0.050$, Cohen' s $d < 0.200$). Furthermore, it has been validated in other cases ((Root Mean Square Error) RMSE = 1.576–2.916). This work provides a new perspective on the accurate reflection of the global vertical displacement state of a foundation pit. Additionally, it enhances the ability to sensitively identify caves in dense karst cave areas, thereby improving the safety of foundation pit works.

Full Text

Preamble

Title: An Intelligent Analysis Method for the Global Vertical Displacement Field of Foundation Pits in Dense Karst Cave Areas

Authors: Jin Liao[1], Chunxiu Lin[2], Chunhui Lan[1], Yongtao Wu[1], Zhen Liu[1], Cuiying Zhou[3]

Affiliations: [1] School of Civil Engineering, Sun Yat-sen University, No. 135 Xingang West Road, Guangzhou 510275, China
[2] The Guangdong Branch Office of Beijing Municipal Engineering Design Research Institute, Guangzhou 510725, China
[3] School of Civil and Transportation Engineering, Guangdong University of Technology, No. 100 Waihuan West Road, Guangzhou University Town, Panyu District, Guangzhou 510006, China

Abstract: Prior research on excavation in dense karst cave foundation pits has primarily focused on evaluating localized spatio-temporal effects and isolated geological factors. However, this approach oversimplifies modeling conditions, limiting comprehensive understanding of the vertical displacement field. Consequently, such oversimplification can inflate safety factors and increase project costs.

To address this limitation, we propose a feedforward neural network (FNN) enhanced with the loop nested optimal iterative method (LNOIM). This approach incorporates the spatiotemporal characteristics of monitoring points and geological factors to analyze the engineering sensitivity of karst caves, ultimately yielding the global vertical displacement field of the foundation pit. Our method demonstrated effectiveness in a foundation pit case study in South China ($P > 0.050$, Cohen' s $d < 0.200$) and was further validated across additional cases (RMSE = 1.576–2.916).

This work provides a new perspective for accurately characterizing the global vertical displacement state of foundation pits. Moreover, it enhances the capability for sensitive identification of caves in dense karst areas, thereby improving the safety of foundation pit engineering.

Keywords: Dense karst caves; Foundation pit; Global vertical displacement; Feedforward neural network; Loop nested optimal iterative method

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