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Article

The Efficiency of Large Hole Boring (MSP) Method in the Reduction of Blast-Induced Vibration

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Abstract: Drill and blast is the most cost-effective excavation method for underground construction, however, vibration and noise, induced by blasting, have been consistently reported as problems. Cut blasting has been widely employed to reduce the blast-induced problems during underground excavation. We propose that the large hole boring method using the state-of-the-art MSP (Multi-setting smart-investigation of the ground and pre-large hole boring) machine ("MSP method") can efficiently improve vibration reduction. The MSP machine will be used to create 382 mm diameter empty holes at the tunnel cut area for this purpose. This study assessed the efficiency of the MSP method in reducing blast-induced vibration in five blasting patterns using a cylinder-cut, which is a traditional cut blasting method. The controlled blasting patterns using the MSP method demonstrated up to 72% reduction in blast-induced vibration, compared to the base case, Pattern B, where only cylinder-cut and smooth blasting method were applied. Therefore, the MSP method proves to be a promising alternative for blasting in sensitive urban areas where non-vibration excavation techniques were initially considered. Geological characteristics of 50 m beyond the excavation face can be acquired through the proposed real-time boring data monitoring system together with a borehole alignment tracking and ground exploration system. The obtained geological information will be a great help in preparing alternative designs, and scheduling of construction equipment and labour during the tunnel construction.

Keywords: tunnel blasting; cut blasting; blast-induced vibration; large hole boring method

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1. Introduction

Drill and blast is widely well-known as the most economical and efficient method to excavate rocks for the construction of underground structures; however, this method has consistently caused problems of vibration and noise due to a large amount of explosives in sensitive urban environments [1–5]. The key factor for tunnel blasting in urban areas is producing maximum blasting efficiency while controlling the blast-induced vibration, and a blasting design was carried out considering the tunnel support pattern and distance from safety facilities [6]. However, there is a limitation in minimizing the blast-induced vibration by reducing the charge per delay and advance per round. Additionally, use of a low-vibration explosive not only delays the construction period but also increases the blasting cost.

Formation of free faces is the most effective way to reduce blast-induced vibration [7,8]; however, tunnels generally have only one free face compared to open-pit mines. Cut blasting is generally performed to create an additional free face, and is the most effective and one of the most commonly utilized methods for reducing blast-induced vibration [9]. V-cut and cylinder-cut, which are traditional cut blasting methods, are mainly adopted to achieve this; however, initial blast-induced vibration is maximized due to concentrated charging of explosives on the cut area to create an additional free face [10]. For this reason, it is difficult to control the vibration within an allowable standard near safety facilities, and various tunnel blasting methods have been developed [11–13].