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Predictive Modelling for Blasting-Induced Vibrations from Open-Pit Excavations

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Abstract: Reliable estimates of peak particle velocity (PPV) from blasting-induced vibrations at a construction site play a crucial role in minimizing damage to nearby structures and maximizing blasting efficiency. However, reliably estimating PPV can be challenging due to complex connections between PPV and influential factors such as ground conditions. While many efforts have been made to estimate PPV reliably, discrepancies remain between measured and predicted PPVs. Here, we analyzed various methods for assessing PPV with several key relevant factors and 1191 monitored field blasting records at 50 different open-pit sites across South Korea to minimize the discrepancies. Eight prediction models are used based on artificial neural network, conventional empirical formulas, and multivariable regression analyses. Seven influential factors were selected to develop the prediction models, including three newly included and four already formulated in empirical formulas. The three newly included factors were identified to have a significant influence on PPV, as well as the four existing factors, through a sensitivity analysis. The measured and predicted PPVs were compared to evaluate the performances of prediction models. The assessment of PPVs by an artificial neural network yielded the lowest errors, and site factors, K and m were proposed for preliminary open-pit blasting designs.

Keywords: peak particle velocity; blasting-induced vibration; prediction; artificial neural networks; site factors K and m; open-pit blasting

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1. Introduction

Drilling and blasting is typically used to fragment rock masses at various building and civil construction sites because it is the most economical means of breaking rock for excavation. However, blasting at construction sites is accompanied by undesirable environmental side effects, such as vibration, noise, and scattering of debris. According to Korea's Office of National Environmental Conflict Resolution Commission, 3840 (approximately 84%) of the 4557 environmental dispute cases on record involve noise and vibration, primarily from construction sites [1]. Blasting vibrations occurring at a construction site account for the majority of these environmental disputes because they result in damage to nearby structures and present various safety concerns. Every country specifies a limit on the peak particle velocity (PPV) of the induced vibrations to minimize damage to nearby structures. According to DIN 4150-3 [2], the limits on PPV are 2 cm/s for buildings used for commercial purposes, 0.5 cm/s for dwellings, and 0.3 cm/s for buildings under preservation orders at a frequency of 1 to 10 Hz. Siskind et al. [3] proposed that 1.9 and 1.3 cm/s are safe levels of blasting vibration for drywall and plaster under 10 Hz conditions. In South Korea, the limits on PPV are 0.2 cm/s for cultural assets and 0.5 cm/s for apartments. Blasting engineers try to accurately predict PPVs that will be induced by blasting and apply the predicted PPVs to the design of blasting patterns to comply with these regulations. Many researchers have studied and proposed various empirical formulas to predict and control PPV [4]. Among the various empirical formulas, a conventional empirical formula