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Analysis of Blasting Efficiency Using Crack-Inducing Holes and Pre-Splitting Method in Blasting

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Abstract: In an era of increased need for underground tunnel excavation to address growing urban population and traffic concerns, complaints resulting from blasting vibrations and the frequent execution of uneconomically inefficient blasting operations due to excessive overbreak have become more prevalent. Therefore, it is necessary to develop blasting methods that can reduce blasting vibrations and minimize overbreak. Various patterns of crack induction holes were placed between the presplitting holes to facilitate the formation of controlled pre-cracks to address the limitations of the presplitting blasting method in this study. The author conducted full-scale experimental blasting at a railway tunnel site and analyzed the blasting effects of the crack induction hole method and pre-splitting technique. As a result of the field test, the pre-formed cracks effectively attenuated vibrations generated in the cut blasting area, reducing blasting-induced vibrations by from 9.3% to 33.5%. Additionally, the amount of overbreak was decreased by from 17.9% to 20.2%. Therefore, the use of crack induction holes and pre-splitting blasting methods in underground tunnel blasting is expected to reduce overbreak, thereby lowering reinforcement costs and minimizing vibrations, preventing damage to adjacent structures. This is expected to enable economically and safely executed tunnel blasting operations both directly and indirectly.

Keywords: crack inducing hole; pre-splitting; combined blasting; vibration reduction; overbreak minimization

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1. Introduction

Underground excavations in urban areas are primarily carried out for the construction of road and railway tunnels to expand transportation networks. Methods for excavating rock-based tunnels can be broadly categorized into blasting methods, which use high-power explosives, and mechanical excavation methods, which crush rock using machinery. With the increasing trend of tunnel excavation projects, various excavation methods have been developed and commercialized. However, from the perspectives of constructability and cost-effectiveness, blasting methods maintain a comparative advantage. Nonetheless, blasting excavation has drawbacks, including complaints arising from vibrations caused by the use of high-power explosives and the tendency for overbreak to expand in weak or highly jointed rock formations [1–3]. An analysis of the environmental dispute statistics published by the Ministry of Environment in December 2023 shows that complaints related to construction site noise and vibration have been increasing annually from 2019 to 2023, posing significant constraints on blasting operations [4]. As a result, extensive research has been conducted to minimize blasting-induced vibrations and overbreak.

One way to reduce blasting vibrations is by improving the tunnel cut area. Jo et al. (2012) showed that installing large-diameter blast holes in the tunnel cut area zone resulted

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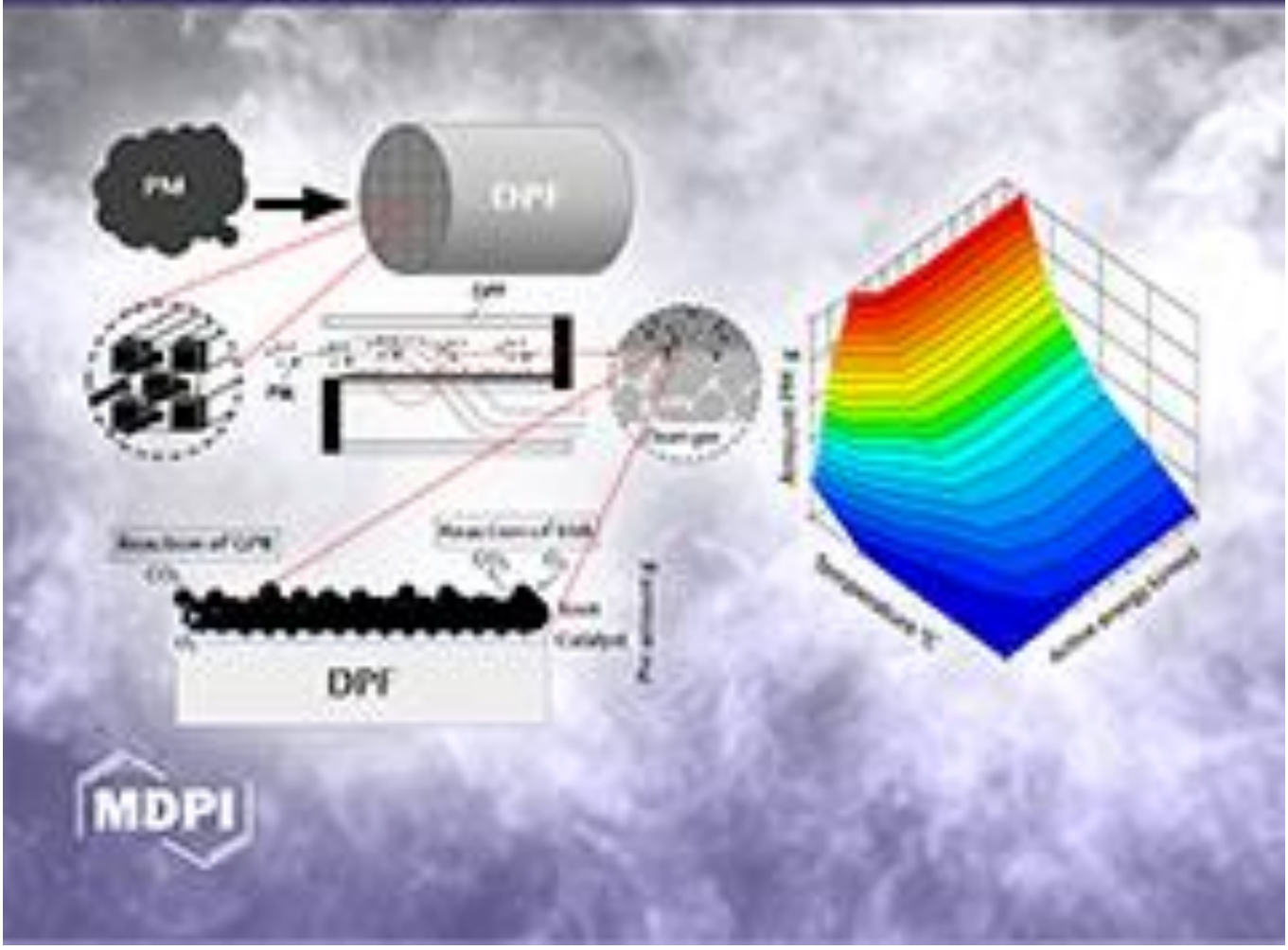

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