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A Study of the Effects of Geological Conditions on Korean Tunnel Construction Time Using the Updated NTNU Drill and Blast Prediction Model

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Abstract: This paper analyses the construction time and advance rate of a 3 km long drill and blast tunnel under various geological conditions using an upgraded NTNU drill and blast prediction model. The analysis was carried out for the five types of Korean tunnel supports according to the rock mass quality (from Type 1, meaning a very good rock mass quality; to Type 5, meaning a very poor rock mass quality). Four kinds of rock properties, as well as the rock mass quality, for each tunnel support type were applied to simulate different geological conditions based on previous studies and the NTNU model. The construction time was classified into five categories: basic, standard, gross, tunnel and total, according to the operation characteristics to more effectively analyse the time. In addition, to consider the actual geological conditions in tunnelling, the construction times for the three mixed geological cases were analysed. It was found that total construction time of a tunnel covering all the operations and site preparations with a very poor rock mass quality was more than twice that of a tunnel with a very good rock mass quality for the same tunnel length. It is thought that this study can be a useful approach to estimating the construction time and advance rate in the planning or design stage of a drill and blast tunnel.

Keywords: construction time; advance rate; NTNU drill and blast model; tunnel support; equivalent rock mass quality

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1. Introduction

In tunnel construction, it is typical to compare the advantages and disadvantages of two major methods, drill and blast (D&B), and TBM, in the planning or design stage. Essentially, a tunnel excavation method is chosen as a result of interaction among various elements such as safety, cost and time schedule [1]. The construction time is an important factor in the selection of the construction scheme (number of construction lots and intermediate construction access) and the construction method (excavation method, lining system) [2].

Hence, for a TBM tunnel, many studies focused on estimating advance rates [3–9], and thus CSM model [10], NTNU model [11], Q_{TBM} [12], etc., were established.

Meanwhile, the D&B method is a very flexible and adaptable process with respect to the excavation of intermediate cross sections or cross sections of any shapes and sizes, and it has advantages in installing the various types of primary rock supports such as shotcrete, wire-mesh, rock-bolt and forepoling. Furthermore, D&B has a short time-mobilisation, as standard equipment is used during the excavation, and has a lower advance rate (performance rate) in most cases, compared to the TBM technology [13].

For a D&B tunnel, some researchers also studied and suggested the usual advance rate of a D&B tunnel. Daller (2017) found that in tunnelling by the New Austrian Tunnelling Method (NATM), the average daily advance rates could reach 10 to 15 m in favourable rock conditions with peak rates up to 20 m/day. Even in poor conditions (e.g., in fault zones),