Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 53(3) (2021)213-214
DOI: 10.22060/ceej.2019.16692.6310

Probabilistic Analysis of TBM Advance Rate Prediction Models

M. Sardari, S H.. Zare* , M. Mazraehli

Mining, Petroleum, and Geophysics Engineering Department, Shahrood University of Technology, Shahrood, Iran.

ABSTRACT: The overall purpose of this study is to use probabilistic methods for the estimation of the advance rate of full-face tunnel boring machines. To collect appropriate input parameters, Monte Carlo Simulation was utilized. Then, the calculation phase was conducted applying established models on input data, and probability density functions of output data were obtained. The results show that the average advance rates calculated by QTBM and CSM models were closer to the average value of the actual advance rates. In addition, using probabilistic methods in combination with TBM prediction models helps to estimate the range of advance rates more confidently.

Review History:

Received: Jul. 06, 2019
Revised: Oct. 02, 2019
Accepted: Oct. 30, 2019
Available Online: Nov. 07, 2019

Keywords:

Probability analysis
Uncertainty, Advance rate
Monte Carlo simulation
Certainty level

1. Introduction

There are different prediction models for TBM performance, all of which have their specific characteristics and have been presented based on intact rock, rock mass, and machine parameters [1-5].

Uncertainties due to geomechanical properties of rocks intersecting tunnel trajectory must be considered in the design stage. Advance rate (AR) is one of the most important parameters affected by rock properties variability in mechanized tunneling. This issue necessitates the application of probabilistic analysis tunneling in a way that must take into account the effect of operational time and cost.

2. Methodology

In this paper, established advance rate models such as NTNU, QTBM and CSM were probabilistically analyzed using Monte Carlo Simulation. The research procedure might be condensed as follows:

1. According to data of the 2nd lot of Laar water conveyance tunnel, proper distribution functions were considered for input parameters.
2. Advance rates were obtained for different geotechnical units of a tunnel at a 95% certainty level with the implementation of the Monte Carlo Simulation using the aforementioned methods.
3. Applicability of the methods was checked using sensitivity analysis.

3. Results and discussion

As it can be seen in Fig. 1, the average predicted advance rates for Ekt are lower than the predicted values for Tgb but the real advance rate is higher for the former unit which might be addressed by assignment of certain parameter values for Tgb while the analysis was conducted using uncertain values for Ekt.

Comparing averaged total advance rates predicted by different methods through Monte Carlo simulation in Fig. 2, it might be concluded that the CSM model could predict the total advance rate more accurately but the values predicted by the other models are far away from the real advance rates.

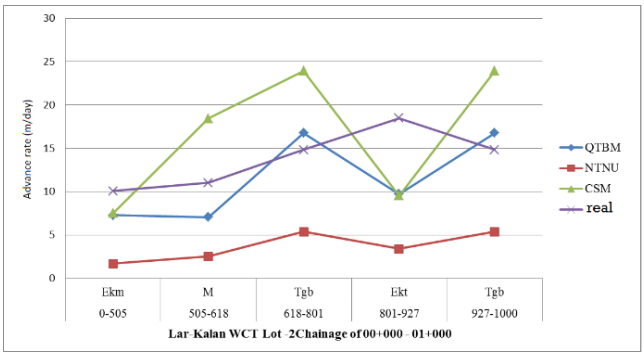

Fig. 1. Comparison of advance rate variation along tunnel trajectory.

*Corresponding author's email: zare@shahroodut.ac.ir

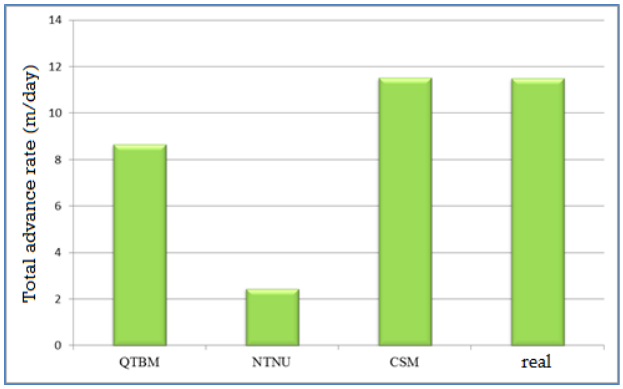

Fig. 2. Comparison of total core recovery.

4. Conclusions

Major findings obtained in this research include:

Average advance rates calculated by QTBM and CSM models were closer to the average value of the actual advance rates.

The use of probabilistic methods in combination with TBM prediction models helps to estimate the range of advance rates more confidently.

Advance rate ranges were predicted far less than their real values using the NTNU model.

In contrast to QTBM and CSM models, operational parameters have more influence on predictions made by using the NTNU model.

References

[1] F. Roxborough, H. Phillips, Rock excavation by disc cutter, International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts, 12(12) (1975) 361-366.

[2] H.P. Sanio, Prediction of the performance of disc cutters in anisotropic rock, International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts, 22(3) (1985) 153-161.

[3] K. Sato, Prediction of disc cutter performance using a circular rock cutting rig, in: First International symposium on Mine Mechanization, Golden, Colorado, 1991.

[4] R.A. Snowdon, M.D. Ryley, J. Temporal, A study of disc cutting in selected British rocks, International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts, 19(3) (1982) 107-121.

[5] L. Ozdemir, Development of Theoretical Equations for Predicting Tunnel Borability, Colorado School of mines, Golden, Colorado, 1977.

HOW TO CITE THIS ARTICLE

M. Sardari, Sh. Zare, M. Mazraehli, Probabilistic Analysis of TBM Advance Rate Prediction Models, Amirkabir J. Civil Eng., 53(3) (2021) 213-214.

DOI: 10.22060/ceej.2019.16692.6310