Cost-effective In-situ Estimation of Rock Properties Using Drilling Data

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Abstract

This paper aims to investigate an alternative technique for estimating the rock failure parameters, namely cohesion and friction angle from drilling data. The traditional method of estimating these parameters involves Mohr's cycles drawn from compressional tests on rock samples. However, acquiring these samples is costly and can be challenging due to availability, continuity, and representability issues. Therefore, this paper proposes using artificial neural networks (ANN) to estimate these parameters, which could improve drilling performance optimization, hydraulic fracturing design, and reduce the risk of wellbore-related problems.

To achieve this objective, more than 2000 data points were collected, each comprising the failure parameters and five drilling records, including the rate of penetration, weight on bit, and torque, that are available instantaneously in drilling rigs. The data was split into three datasets, with 60% for training, 20% for testing, and 20% for validation. The ANN models were optimized and evaluated using the correlation coefficient (CC) and average absolute percentage error (AAPE).

The results showed that the ANN models for both friction angle and cohesion produced a good fit with the actual values, demonstrating the ability to estimate rocks' mechanical properties with good reliability and at no additional cost. The friction angle model yielded CC values around 0.86 and AAPE values around 4%, while the cohesion model resulted in CC values around 0.89 and AAPE values around 6%.

These findings indicate the potential of the proposed method to be used as an alternative to the traditional Mohr's cycle method for estimating failure parameters in rocks. The novelty of this study lies in the use of ANN models to estimate failure parameters in rocks from drilling data, which has the potential to improve the efficiency and accuracy of rock mechanical property estimation.