MONTANA
Department of Transportation
Research

March 2025

Performance Measures Report
FHWA/MT-25-001/10118-877

More Info:

The research is documented in Report FHWA/MT-25-001/10118-877

Principal Investigator
Curtis A. Link
clink@mtech.edu
406.496.4611

MDT Technical Contact
Jeff Jackson
jejackson@mt.gov
406.444.3371

MDT Research Project Manager
Vaneza Callejas
vcallejas@mt.gov
406.444.6338

ORGANIZATION AND ANALYSIS OF MEASUREMENT WHILE DRILLING (MWD) DATA

https://www.mdt.mt.gov/research/projects/mwd.aspx

The Montana DOT (MDT) project *Organization and Analysis of Measurement While Drilling (MWD) Data*, resulted in development of a GIS based data portal which the research team used to access the various MWD data types and perform analysis. Analysis involved quality control of the various data types, choosing subsets of MWD and drilling data and performing correlations.

Initial correlation analysis consisted of plotting target parameters (SPT blow count, UCS, and unit weight) against six individual MWD parameters: depth, down pressure, rotation torque, rotation speed, moving speed and the compound parameter specific energy. A best fit linear regression line was calculated and the R^2 coefficient recorded for each MWD parameter. We also explored single parameter correlation results using a best fit exponential curve and tabulated those R^2 values as well.

Additional analysis approaches were explored and ultimately consisted of three phases:

1. Single parameter linear correlation (described above),
2. Multiple parameter linear correlation (using every possible combination of the six inputs – 63 combinations in all) and
3. Multiple parameter nonlinear correlation (artificial neural networks) also using all 63 combinations of inputs.

Exploring correlations using this multi-phase approach, we found that the phase three approach implementing neural network modeling produced the best results for predicting the three target parameters. Ranking predictive capability for each target parameter, SPT blow count consistently achieved the highest predictability regardless of the combination of inputs. The final report details modeling results for each of the 63 possible combinations of inputs. Nonlinear neural network correlation results for UCS produced poorer predictability results than SPT blow count but still better than single or multiple parameter linear modeling. Predicting the target unit weight gave results somewhat better than predicting UCS.

The borehole target data were collected in two forms: SPT blow counts from approximately the upper 30 feet in depth and core data below 30 feet depth. A possible explanation for poor predictability of rock core targets is the geologic setting that the MWD and borehole data came from. All of the MWD/borehole data came from an approximately 20 mile stretch of highway in eastern Montana. Trying to understand the poor predictability results, we hypothesize that working in intermediate geomaterials (IGMs) categorized as extremely weak rock (35 to 150 psi) and very weak rock (150 to 725 psi) could be a major contributing factor. Noting that predicting SPT blow counts showed good predictability, blow count data are collected from in-situ material compared to borehole coring data from retrieved samples which are removed in a coring tube. Given the nature of the weak IGM material, borehole coring measurements (UCS and unit weight) are likely affected by removal from the in-situ setting. Another possibility was the fact that MWD data were collected in the same borehole that sampling was done which could have a possible impact on modifying the in-situ materials.

Based on our modeling results for the particular geologic setting our data came from, using MWD inputs to predict SPT blow counts could be a viable method to produce a continuous SPT blow count profile in the top approximately 30 feet of geomaterial. This would lead to improved efficiency at the drilling site (eliminating the SPT blow count testing) and increasing the resolution of an SPT blow count profile with depth.