CHAPTER VII

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a discussion on the consistency of experimental results obtained from CERCHAR abrasivity testing under varying bedding plane orientations and scratching directions. The influence of different rock types, anisotropic structures, and mechanical responses on the measured parameters, CERCHAR abrasivity index (CAI), ploughing force (F), groove volume (V), work energy (W), and CERCHAR Scratch Energy (CSE) is evaluated. Limitations of the study are also addressed. Conclusions are drawn based on the relationships identified among the test parameters and boundary conditions

7.1 Discussions

The correlations between the CERCHAR Abrasivity Index (CAI), ploughing force (F), groove volume (V), scratch width (W), and CERCHAR Scratch Energy (CSE) across all rock types and boundary conditions suggest that the testing procedure yields consistent and interpretable results. Strong rocks, such as the Khao Khad limestones, tend to produce higher CAI and F values but generate lower groove volumes as compared to softer rocks like Tak Fa gypsum. Work energy (W) shows a direct relationship with F, as it corresponds to the area under the force–distance curves.

The relationship between CSE and CAI, however, is not straightforward. For example, Phu Phan sandstone, which shows a medium CAI, shows a lower CSE than the softer Tak Fa gypsum. This result implies that the specific energy used in scratching (CSE) does not consistently correlate with the stylus tip. This inconsistency may arise from the fact that CSE is derived from energy consumption along the entire scratch path, not solely from the stylus tip response.

In terms of anisotropy, higher CAI values are observed when the scratching direction is opposite to the dip direction of the bedding plane orientation (α) Under this condition, the alternation of soft and hard layers along the scratch path amplifies stylus wear. Conversely, when the scratching direction follows the bedding dip, CAI and F values are reduced, while larger groove volumes are observed. These findings align with the influence of scratching direction (θ), where the highest CAI, F, and V values occur when the stylus moves perpendicular to the bedding trend (θ = 90°).

For clastic rocks, scratching across bedding planes composed of layers with contrasting grain sizes produces greater stylus wear (higher CAI) than scratching along bedding planes composed of homogeneous layers. In crystalline rocks, variations in CAI depend on the hardness contrast among the crystallized layers. If these layers (e.g. calcite) have similar hardness, the bedding plane orientation has little effect on stylus tips.

Rocks with well-defined bedding planes tend to yield stronger correlations among CAI, ploughing force, and groove volume than those with poorly developed structures. However, due to the limited range of bedding thicknesses in the tested specimens (0.5–2 mm), its influence could not be fully assessed in this study. Furthermore, the correlation between CSE and the other parameters remains poor, primarily because CSE does not originate from direct measurement at the stylus tip.

7.2 Conclusions

Results from this study can be concluded as follows.

1) The scratching directions (θ) affect CAI and force than does bedding plane orientations (α).

2) Bedding plane orientation influences the CAI of strong rocks more severely than that of soft rocks.

3) Scratching across bedding planes generally results in higher CAI values than scratching along them.

4) CERCHAR scratch energy (CSE) does not inversely correlate with CAI and may be unreliable as a wear indicator, as it is derived from total energy consumption rather than stylus tip behavior.

5) These findings suggest that in practical applications, particularly in mechanical excavation using roadheaders or cutting tools for mineral extraction, aligning cutting direction parallel to bedding planes can reduce tool wear and improve equipment durability.

7.3 Recommendations for future studies

The suggestions for additional studies are as follows:

1) The range of bedding plane orientations and scratching directions should be expanded to provide more comprehensive coverage and identify critical angular relationships affecting stylus wear.

2) The influence of bedding plane thickness should be studied, which could not be adequately assessed in this study due to the limited range (0.5–2 mm) in the tested specimens.

3) Mineralogical properties that affect rock abrasiveness should be studied, with particular attention to mineral hardness, bonding strength, and distribution within the rock matrix.

4) Environmental factors such as water content, grain or crystal size, and temperature should be intraportal in the future study as they are commonly encountered in in-situ conditions and may influence abrasivity and tool wear.