CHAPTER I

INTRODUCTION

1.1 Background and Rationale

CERCHAR abrasivity index (CAI) is widely used for evaluating the abrasion resistance of cutting tools. Its popularity is attributed to the method's simplicity, speed, and low cost Prieto, (2012); Ko, Kim, Son and Jeon, (2016); and Hamzaban, Karami and Rostami, (2013), which has driven extensive research to obtain various practical outcomes. The relationship of the CERCHAR abrasivity index (CAI) with various factors has been extensively developed, including testing length Al-Ameen and Waller, (1994); Plinninger, Käsling, Thuro and Spaun (2003); Yarail and Duru, (2016), velocity Kotsombat, Thongprapha and Fuenkajorn (2020); Plinninger, Kasling, and Thuro (2004), surface conditions Plinninger, et al., (2003); Thanadkha and Fuenkajorn (2022), mineral and rock compositions Kathancharoen and Fuenkajorn (2023), orientation, temperature and mechanical properties Hamzaban, Memarian and Rostami, (2013); Capik and Yilmaz, (2017); Alber, (2008); Deliormanli, (2012).

Despite extensive research on CAI, the current understanding does not fully account for all variables influencing it. In particular, the effects of joint frequency and aperture in rock are critical factors that remain underexplored. This study introduces a new concept that highlights the significance of these structural features on CAI when assessing tool wear. For instance, when a drill bit encounters a rock formation with a higher number of joints or wider apertures, these features significantly affect performance, leading to increased wear or reduced drilling efficiency. Understanding these effects is crucial for enhancing the predictive accuracy of CAI and optimizing drilling operations in geologically complex environments.

1.2 Research Objectives

The objective of the study is to investigate the effect of rock joint characteristics on CERCHAR abrasivity index under varying numbers of joints and joint apertures. Number of joints and their apertures are considered. Three rock types have been tested. Methematical relations between CAI and joint characteristics are developed.

1.3 Scope and Limitations

The scope and limitations of the research include as follows:

1) Three rock types are tested: sandstone from the Phu Phan formation and collected from Nakhon Ratchasima, limestone from the Khao Khad formation and collected from Saraburi and basalt from the Buriram formation and collected from Nakhon Ratchasima.
2) Number of joints are varing from 1-4 with constant joint spacing of 2 mm.
3) Joint aperture are rating from 0, 0.3, 0.5 and 0.8 mm.
4) CAI uses saw-cut surface.
5) The CERCHAR procedure follows ASTM D7625-22 standard practice.
6) Mineral compositions are determined by X-ray diffractometer.
7) Ploughing forces and grooves volume of CAI specimens are measured.

1.4 Research Methodology

The research methodology in Figure 1.1 includes literature review, sample preparation, CERCHAR testing, laser scan, X-ray diffraction analysis, mathematical relations, discussions and conclusions, and thesis writing.

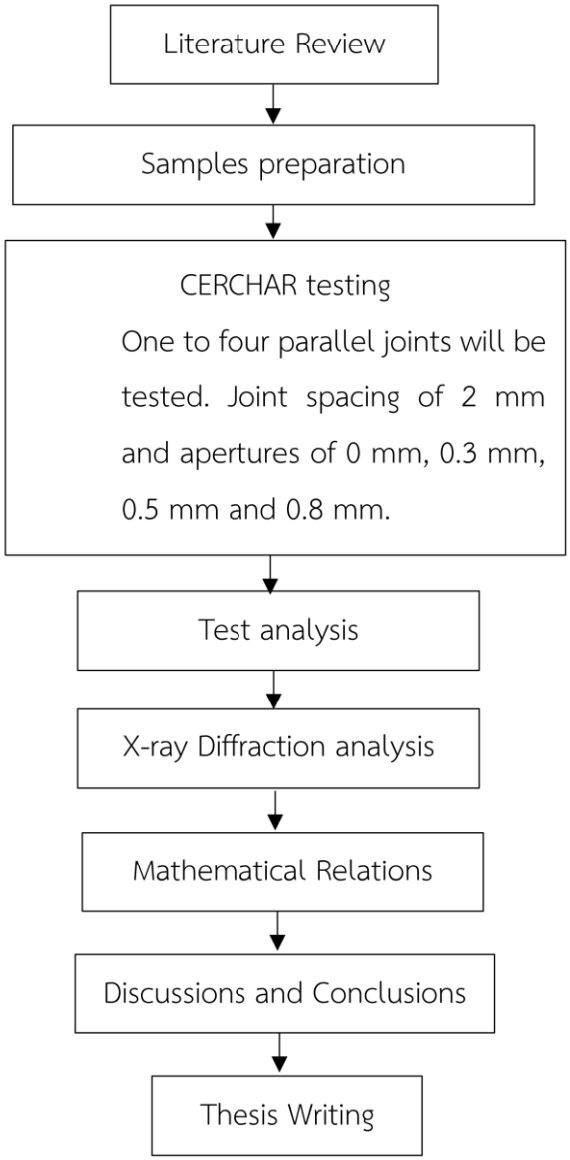

Figure 1.1 Research Methodology.

1.4.1 Literature Review

A literature review are carried out to study research about rock abrasiveness and joint discontinuity, CERCHAR testing, and effect factors on CAI. The sources of information are journals, technical reports, and conference papers.

1.4.2 Sample preparation

The rock specimens are cut and ground to produce saw-cut surface in accordance with the ASTM D7625-22 standard practice. Rectangular block specimen with nominal dimensions of 80×50×40 mm^3 are obtained with artificial fractures (saw-cut) normal to the test surfaces. The numbers of parallel joints are varied from 1 to 4, with joint apertures from 0 to 0.8 mm. The joint apertures are made by using filler gages placed between thin slaps of rock specimens to obtain a precise gap (aperture) between them.

1.4.3 CERCHAR testing

The testing are conducted to determine CAI of rock specimens with different joint numbers and spacing. The test procedure follows the ASTM D7625-22 standard practice with additional parameters vertical displacements and scratching force.

1.4.4 Test analysis

The Cerchar abrasivity Index (CAI) is determined as a function of joint numbers and joint apertures. The correlations between CAI and groove volume, obtained from surface scratching of the rock, are also examined. These correlations are analyzed for all rock joints and apertures. The findings reveal in the response of rock joints and apertures on CAI which provides insights into the processes that occur during excavation.

1.4.5 X-ray Diffraction analysis

In the X-ray diffraction (XRD) analysis, rock samples are finely ground to a powder with a particle size of 250 μm (mesh #60). The analysis results are utilized to assess the influence of mineral compositions on CAI. XRD analysis is conducted on the finely ground rock powder after CAI tests to determine the mineralogical composition, which is one of the key factors affecting the CAI.

1.4.6 Mathematical Relations

The mathematical relations are derived from the test results of CAI value, rock joint numbers and spacings to predict the CAI value as affected by rock joints on the CERCHAR abrasion index of three types of rock. Methematical relations between CAI and joint characteristics are developed.

1.4.7 Discussions and Conclusions

All activities, methods, and results are recorded and compiled in the thesis, including guidelines for continuing research results in the future.

1.5 Thesis content

This research thesis is divided into eight chapters. The first chapter includes background and rationale, research objectives, scope and limitations and research methodology. Chapter II presents results of the literature review to improve an understanding of CERCHAR testing. Chapter III describes sample preparation. Chapter IV describes the test method. Chapter V presents the experimental results. Chapter VI assesses the predictive capability of some rock, determine the effects of joint frequency and joint aperture on of rock and to assess the volume of rocks obtained from excavation. Chapter VII presents discussions, conclusions and recommendation for future studies.