CHAPTER I
INTRODUCTION

1.1 Background and rationale

Sandstone formations shape landscapes worldwide, but their susceptibility to erosion process is challenging for engineering works, for examples slope embankments, dams, and reservoirs. In northeast of Thailand, sandstones are layering deposited, where Phu Phan and Phra Wihan formations host a variety of infrastructures and constructions within the area. To understand the erosion process, several investigators attempt to study the governing factors and forecast their behaviors in long-term conditions (Jamshidi, 2023; Moradian, Ghazvinian, Ahmadi, & Behnia, 2010; Xiang, Latham, & Pain, 2022). The complexity of field factors limit the ability to isolate internal factors and specific mechanisms, while laboratory simulations offer a controlled environment to accelerate the process, examine specific factors, and develop a deeper understanding of the erosion dynamics for sandstones. The relative importance of these factors can be correlated to predict the potential behaviors of rocks. Nichols (2009) reports that the resistance to this process can be described in terms of durability parameters. One of the prevalent methods is slake durability index [SDI] tests, as specified by the American Society for Testing and Materials [ASTM], (ASTM D4644, 2016). The determination and classification for this index have widely been developed to correlate the degradation degrees between rocks (e.g. Ergular & Shakoor, 2009; Franklin & Chandra, 1972; Moradian et al., 2010; Zhu & Deng, 2019). However, recent studies concentrated using this method for rock durability only in terms of physical weathering process. To develop this technique for erosion process. The movement of rocks and transport velocity are concerned with the estimation of consumption energy

during erosion process. The mathematical representation correlating between degrees of erosion and the required energy is developed. This study would be useful as one of the technique to apply for long-term prediction of rock erosion with the correlation parameters under laboratory simulation. The assessment of the energy consumption for rock erosion can be useful for further understand of rock degradtion behaviors in the selective area.

1.2 Research objectives

The objective of this study is to simulate the effect of erosion process on three Thai sandstones. The main task involves performing slake durability index test under dry and wet conditions. Test parameters are increasing up to 2,000 revolutions for 80 cycles beyond the ASTM D4644-16 standard specifications to obtain results that can represent long-term durability of rock specimens. Mineralogical and physical characteristics of the specimens are considered in the analysis. The specimens durability is correlated with the energy required to induce different degrees of degradation, and hence allows predicting long-term erosion process for the rocks.

1.3 Scope and Limitations

The scope and limitations of the study include as follows:

1) Slake durability test will be performed on cubic specimens, prepared from Phu Phan conglomeratic sandstone, Phu Phan and Phra Wihan sandstones.
2) The nominal mass for cubic specimens are 50±5 g.
3) Slake durability tests procedure will be modified from ASTM D4644-16 standard by performing from 200 to 2,000 revolution and increasing up to 80 test cycles (days) for each rock specimens.
4) The tests will be performed under wet and dry conditions with controlled of ambient temperature for 25±2 °C.
5) The oven-dry setting are controlled with 105±5 °C for 20 hours.

6) Weight measurement is analyzed before testing in each test cycle to determine mass balance.
7) Surface observation and physical measurements are analyzed every 20 cycles.
8) Rock fragments before and after test through 80 cycles are analyzed mineral compositions.
9) Passing materials from the drums are collected after each test cycle for all conditions and analyzed mineral compositions using X-ray diffraction analysis.

1.4 Research methodology

The research methodology shown in Figure 1.1 comprises six steps: including literature reviews, sample collecting and preparation, slake durability test and physical measurements, test results and analysis, energy analysis, discussions, conclusions, and thesis writing.

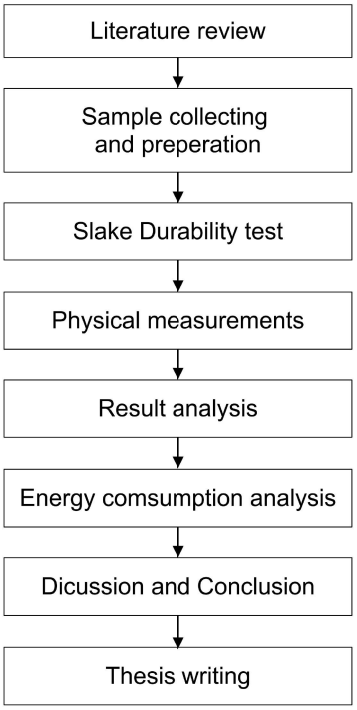

Figure 1.1 Research methodolody

1.4.1 Literature review

Literature review will be performed to enhance the understanding of terms and definitions for erosion and related processes. This section also include with developed techniques reflecting the degradations through rocks durability and their energy consumption. The reviwed for relative of erosional factors under field and laboratory conditions will be conducted to explain mechanisms for erosional process. The erosional factors due to mineralogical and physical characteristics on previous researches are determined for better understanding of rock erosion behaviors.

1.4.2 Sample collecting and preparation

Rock samples are collected from northeast of Thailand. Phra Wihan sandstone and conglomeratic and bedded sandstones from Phu Phan formation are selected for this study. Each rock type is prepared into cubic shape. Twenty specimens are setted for each condition with an average mass of 50 g. The nominal dimension of initial fragments had approximate axes of 27.5 mm^3.

1.4.3 Slake durability test

The slake durability is tested follows the suggestion of ASTM D4644-16 standard (ASTM, 2016). The tests are modified from the standard by performed 2,000 revolutions, instead of 200 revolutions and incresed test cycles up to 80 from 2 cycles. Each set of ten cubical fragments are subjecting to dry and wet conditions. After each test cycle, fragments are heated with 105 $\pm$ 5 °C over 20 hours. Before testing in the next cycle, each fragment is cooled down at ambient temperature for 1 hour and weight measurement. Surface observations are analyzed with an interval of 20 test cycles. The particles passing through the drums are collected for X-ray diffraction (XRD) analysis.

1.4.4 Physical measurements

Physical properties include: density, shape, and size are measured for every 20 test cycles. For density, the measurement is conducted as suggested by ASTM D7263-21 standard test method. Variation of shapes and sizes determination follows the method from Hryciw et al. (2016). The mineral contents for fragments from each rock type are analyzed before and after test through 80 cycles. The passing materials are also collected for mineral analysis.

1.4.5 Results analysis

The physical properties are correlated to conduct the characteristics of each rock under dry and wet conditions. The mineral compositions of fragments before and after 80 test cycles wil be analyzed as a volumatic weight percents for calcuclated porosity. The analysis will be followed the method of Chamwon, Thongprapha, and Fuenkajorn (2020), where the results comparing to those obtained from ASTM D7263-21 (ASTM,2021) standard test method. The passing materials from slake durability tests under both conditions are analyzed as the accumerative passing weight percents for further analysis of required energy for rock degradations.

1.4.6 Energy consumption analysis

The mathematical relationship is represented the degradation energy for rocks from each test cycle. The results are expressed to establish the rock erosion prediction. Energy assessments according to the statistical analysis is further applied for each rock with its fragments size.

1.4.7 Discussions and Conclusions

Discussions and conclusions in this study will make on the reliability and adequacies of the approaches used to determine the resulting relationship. The

thesis will include research activities, methods, and results. The research or results will be published in conference proceedings or journals.

1.4.8 Thesis writing

All research activities, methods, and results will be documented and complied in the thesis. The findings will be published in conference proceedings or journals.

1.5 Thesis content

The contents are presented through eight chapters. Chapter I introduces the background, objectives, scope, limitations, and briefly method uses in this study. Chapter II summarizes previous researches including definitions and terms of erosion process with previous simulation techniques, erosional factors, and energy involving in environmental systems. Chapter III describes collecting area, sample preparation and physical properties for PWSS, PPCS, and PPSS specimens before testing. Chapter IV explains test methods for slake durability test and physical measurements. Chapter V shows test results. Chapter VI offers the analysis for physical properties and the passing materials from slake durability tests. Chapter VII represents energy using for three rocks to disintgrate and their applications. Chapter VIII discusses and concludes the obtained results. Future studies are recommended for further knowledge that should be concerned.