

## TABLE OF CONTENTS

APPROVAL PAGE .....	iii
ENDORSEMENT PAGE.....	iv
STATEMENT PAGE.....	v
PREFACE .....	vii
TABLE OF CONTENTS .....	viii
LIST OF TABLES .....	xi
LIST OF PICTURES .....	xii
INTISARI.....	xiv
ABSTRACT.....	xv
CHAPTER I INTRODUCTION .....	1
1.1 General Background .....	1
1.2 Problem Statement .....	2
1.3 Objectives .....	3
1.4 Scope and Limitation .....	3
1.5 Research Benefits.....	3
1.6 Thesis Structure .....	3
CHAPTER 2 LITERATURE REVIEW .....	5
2.1 Previous Studies.....	5
2.2 Research Authenticity .....	12
CHAPTER 3 THEORETICAL BACKGROUND.....	13
3.1 Soil.....	13
3.1.1 Soil composition .....	14
3.1.2 Soil properties .....	14
3.1.3 Soil grain size distribution .....	16
3.2 Problematic Soils .....	18
3.3 Soil Improvement.....	18
3.2.1 Cement Grouting.....	20
3.2.2 Biogrouting .....	21
3.3 Enzyme Induced Calcite Precipitation.....	22
3.3.1 Overview .....	22
3.3.2 Urease enzyme plant source.....	24

3.3.3	Factors that affected carbonate crystallization .....	24
3.3.4	Application methods .....	26
3.4	Advantages of EICP .....	27
3.5	Calcite Content Quantification .....	27
3.4.1	ASTM D4373-21 .....	30
3.5	Unconfined Compression Strength (UCS).....	31
3.5.1	Pocket penetrometer .....	31
CHAPTER 4 RESEARCH METHODS .....		33
4.1	Location .....	33
4.2	Materials .....	33
4.2.1	Sand.....	33
4.2.2	Soybean.....	34
4.2.3	Urea.....	34
4.2.4	Calcium chloride .....	35
4.2.5	Hydrochloric acid.....	35
4.3	Research Procedures .....	36
4.3.1	Literature review .....	38
4.3.2	Preparation of sample model configuration .....	38
4.3.3	Preparation of urease solution.....	40
4.3.4	Preparation of reagent solution .....	42
4.3.5	Cementation solution mixing .....	42
4.3.6	Soil sample cementation .....	43
4.3.7	Curing.....	44
4.3.8	Penetrometer testing.....	44
4.3.9	Calcite content testing .....	45
4.3.10	Data analysis .....	46
4.3.11	Report arrangement.....	46
4.4	Analysis Method .....	46
CHAPTER 5 RESULTS AND DISCUSSION .....		48
5.1	Preliminary Calculation Results .....	48
5.1.1	Sand requirement calculation .....	48
5.1.2	Solution requirement calculation .....	49
5.2	Visual Analysis of Cemented Soil .....	50
5.3	Calcite Distribution Evaluation.....	55

5.4 Soil Strength Evaluation .....	57
CHAPTER 6 CONCLUSION AND RECOMMENDATION.....	60
6.1 Conclusions .....	60
6.2 Recommendations .....	60
BIBLIOGRAPHY .....	61
APPENDIX .....	67
APPENDIX 1 .....	68
APPENDIX 2 .....	72