

Table of Contents

Abstract	ii
Acknowledgments	iii
List of symbols	v
List of Abbreviations	vii
1 Introduction	1
1.1 General.....	1
1.2 Layout of the thesis.....	1
1.3 Statement of the problem.....	3
1.4 Significance of the study.....	5
2 Aims and Objectives	6
2.1 Scope of research.....	6
2.2 Aims.....	7
2.3 Objectives.....	8
2.3 Hypothesis.....	9
3 Literature Review and Background Studies	10
3.1 Introduction.....	10
3.2 Pile foundations.....	11
3.3 Absence of pile foundations in the Al-Hasa area.....	15
3.4 Local experience.....	16
3.5 Problematic soil in the area.....	17
3.5.1 Marl.....	17
3.5.1.1 Calcareous soil	17
3.5.1.2 Engineering Behavior of Calcareous soil	19
3.5.1.2.1 Non- Sedimentary Calcareous soil	
3.5.1.3 Geotechnical properties of Calcareous soil	22
3.5.1.3.1 Atterberg Limits clay	
3.5.1.3.2 Grain-size Distribution	
3.5.1.3.3 Soil Strength	

3.5.2	Sabkha.....	28
3.5.2.1	Sabkha Soil	
3.5.2.2	Types of Sabkha Soils	
3.5.2.3	Distribution of Sabkha Soils	
3.5.3	Sand.....	32
3.5.3.1	Problem Statement	
3.5.3.2	Types of Sands	
3.5.3.3	Aeolian Deposits in the Arabian Peninsula	
3.5.3.4	Mineralogical Composition of Sands	
3.5.3.5	Gradation of Sands	
3.5.3.6	Sand as a Construction Material	
3.5.4	Expansive Soil	39
3.5.5	Subsurface Cavities	40
3.5.4.1	Natural Cavities	
3.5.4.2	Problems Induced by Subsurface Cavities	
3.5.4.3	Methods for Detecting Subsurface Cavities	
3.6	Geotechnical Characteristics of Weak Soil in the <i>Al-Hasa</i> Area	46
3.6.1	Geotechnical Characteristics of Clay	
3.6.2	Geotechnical Characteristics of Sabkha	
3.6.3	Geotechnical Characteristics of Expansive Soils	
3.7	Summary	48
4	Research Methodology.....	50
4.1	Introduction.....	50
4.2	Case Studies:.....	52
4.2.1	Case study 1: Pile foundation of Al-Hasa Holiday Inn Hotel	
4.2.2	Case study 2: Pile foundation of Al-Hasa hospital	
4.3	Parametric Studies.....	54
4.4	Existing commercial software for pile foundation analysis.....	56
4.4.1	Choosing the suitable software for this study	
4.4.2	Verifying results of ELPLA	
4.4.3	Describing the program ELPLA	
4.4.4	Describing ELPLA-Modules	
4.4.5	Calculation methods of ELPLA	

4.4.6 Typical application of ELPLA

5	Results and Analysis.....	69
5.1	Introduction.....	69
5.2	Case study 1: Pile foundation of Al-Hasa Holiday Inn Hotel.....	70
5.2.1	Description of the project	
5.2.2	Geotechnical investigation	
5.2.3	Soil parameters	
5.2.4	Pile caps, raft and pile material	
5.2.5	Analysis of the foundation	
5.2.6	Results and discussions	
5.3	Case study 2: Pile foundation of Al-Hasa hospital.....	128
5.3.1	Description of the project	
5.3.2	Geotechnical investigation	
5.3.3	Soil parameters	
5.3.4	Pile caps, raft and pile material	
5.3.5	Analysis of the foundation	
5.3.6	Results and discussions	
5.4	Parametric Studies.....	167
5.4.1	General	
5.4.2	Studied groups of pile caps	
5.4.3	Ranges of parametric study variables	
5.4.4	Type of soil	
5.4.5	Results and discussions	
5.5	Cost Optimization.....	195
5.5.1	Introduction	
5.5.2	Calculation Method	
5.6	Summary.....	203
6	Discussion.....	206
7	Conclusion and Recommendations.....	215
7.1	Conclusions.....	215
7.2	Recommendations and future work.....	219

References 220

Appendix A: Figures analyzing pile foundation of Al- Hasa Holiday Inn Hotel

Appendix B: Figures analyzing pile foundation of Al Hasa Hospital

Appendix C: Tables & Diagrams of Parametric Study

Appendix D: Theoretical basis

Appendix E: Pile Foundation in Al-Hasa Area, Saudi Arabia (Published Paper)

Appendix F: Soil test report & scheme of pile load test