



# **Collapse of Excavations and its Impact on the Cost and Time of the Project Implementation**

**Prepared by:**

**Heba Anwar Sadi Al-Alawi**

**Supervised by:**

**Dr. Orabi Al Rawi**

**This Thesis was Submitted in Partial Fulfillment of the Requirements for Master Degree of Engineering Project Management**

**August 2019**

## **ACKNOWLEDGMENT**

My sincere gratitude goes to Dr. Orabi Al Rawi for his continuous assistance and guidance throughout the preparation of this thesis. His amazing generosity of his time, patience, and remarkable advice are greatly appreciated.

My heartfelt thanks go to people in engineering companies and other organizations in Jordan who provided me with the required support and greatly enhanced my knowledge.

My genuine appreciation and thankfulness go to my beloved parents for their understanding patience, and moral and material support during all the stages of working on this research.

# Authorization Form

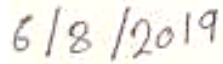
## Authorization Form

I'm Heba Anwar AL-alalwi, authorize Isra University to supply copies of my Thesis to libraries, establishments or individuals on request, according to Isra University regulations.

Signature:

A handwritten signature in black ink, appearing to be 'Heba Anwar AL-alalwi', written over a yellow rectangular background.

Date:

A handwritten date '6/8/2019' in black ink, written over a yellow rectangular background.

## Committee Decision

This thesis " Collapse of Excavations and its Impact on Cost and Time of Project Implementation" was successfully defended and approved on \_\_\_\_\_ 2019.



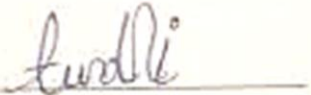
Examination Committee Signature

Signature

Dr. Orabi Al Rawi (Supervisor)

Associate Professor of Civil Engineering

Isra University

Prof. Sultan Al Tarawneh (Member)

Professor of Civil Engineering

Mutah University

Dr. Faidhi Abdulrahman Alubaid (Member)

Associate Professor of Civil Engineering

Isra University

## DEDICATION

I extend my sincere thanks and gratitude **Dr. Orabi Al Rawi** for his continuous guidance and constant support during the preparation of this thesis, and I would like to thank him for his patience, assistance, amazing generosity and wonderful advice during my educational career

To the one who taught me to give with expectation of return... who I carry, his name with all bride, I ask Allah to prolong your life to load the long-awaited treasure. Your words will remain starts that guide me today, tomorrow and forever, **My dear Father**

I dedicate my graduation to the one who is the key to heaven. **My mother**, I would like to express my love and gratitude, Thanks to your continuous help and support, my dream has become true. Your help, wonderful words have driven me to success, study, optimism and patience.

I dedicate this work to the one who taught me that success is not achieved but with patience and insistence, to the one who share the life with me step by step, to my second mother and companion, who has always encouraged me at all times, to the innocent face and calm simile, to my mother in law, the great teacher, **Fatima Al-Ali**.

To the love of my life, my other half, who has supported me to reach the target, my companion, who has given me a hand all times to make difference, my husband, **Waleed Al-Manaseer**

To my brother, sisters, friends and colleagues, I ask Allah to bless and protect you, I have always been proud of you, to all of you, I dedicate this thesis.

I hope this thesis is accepted by the honorable and esteemed members of the discussion committee.

*Heba Anwar Al-Alawi*

# **Collapse of Excavations and its Impact on Cost and Time of Project Implementation**

## **Abstract**

This research aims to conducting evaluations for the influence of side collapse of excavations on the estimated cost and time for a proposed project.

The methodology applied in this research is to comprise several phases. The first phase focused on identifying factors, methods, and previous studies concerning the side collapse of excavations for construction projects. However, this phase included site visits to several construction projects with a focus to a selected case study in Amman. the second phase focused on designing a survey questionnaire regarding attitudes for the major factors affecting the side collapse of excavations in Jordan and their accompanies with the time and cost of carrying out the intended project, and then distributing this questionnaire to several engineers and experts working in the field of construction.

The next phase for the research methodology was the analysis of the collected data (resulted from the distributed questionnaire) using SPSS program.

Finally, the last phase of this research was concentrated on developing guidelines and preparing conclusions and recommendations.

Based on the analysis of the field survey, the results indicated that there are various factors that affecting the side collapse of excavations for construction projects. It was concluded that the most important factor was the weather conditions and other surrounding conductions, in addition to Planning and following-up the methods used to protect commercial project excavations from collapse. Among other parameters, the lack of interest to plan for the time needed to conduct the required investigation is one of the significant results. Also lack of supplies for the project site

prior to implementation (with emphasis on commercial building sites), facilitating the passage of workers and excavations to the project, and securing the side traffic at the project, as verified by the case study

Accordingly, it is recommended that project managers before the implementation of the project shall investigate the methods to prepare the project before the start, in order to prevent the collapse of the side of the excavations for the construction projects, and the importance of working schedules required for all phases of the project so that no increase in the time and cost required to establish the project on the required quality.

## TABLE OF CONTENTS

ACKNOWLEDGMENT .....	I
AUTHORIZATION FORM.....	II
COMMITTEE DECISION .....	III
DEDICATION.....	IIIV
ABSTRACT .....	V
TABLE OF CONTENTS .....	VII
LIST OF TABLES .....	XI
LIST OF FIGURES .....	XII
ABBREVIATIONS .....	XIII
<b>CHAPTER ONE: INTRODUCTION .....</b>	<b>1</b>
<b>1.1 PREFACE .....</b>	<b>2</b>
<b>1.2 RESEARCH BACKGROUND .....</b>	<b>3</b>
<b>1.2.1 Overview to the Side Collapses of Project Excavations .....</b>	<b>3</b>
<b>1.3 RESEARCH PROBLEM STATEMENT .....</b>	<b>5</b>
<b>1.4 LIMITATIONS OF STUDY.....</b>	<b>6</b>
<b>1.5 RESEARCHHYPOTHESIS .....</b>	<b>7</b>
<b>1.5.1 Null hypothesis (H0) .....</b>	<b>7</b>
<b>1.5.2 Alternative hypothesis.....</b>	<b>7</b>
<b>1.6 RESEARCH OBJECTIVES .....</b>	<b>7</b>
<b>1.7 STRUCTURE OF THE THESIS.....</b>	<b>8</b>
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>9</b>
<b>2.1 INTRODUCTION.....</b>	<b>10</b>
<b>2.2 SIDE COLLAPSES OF EXCAVATIONS .....</b>	<b>10</b>



<b>2.3</b>	<b>MAIN FACTORS AFFECTING THE OCCURRENCE OF SIDE COLLAPSES .....</b>	<b>10</b>
2.3.1	<i>Nature of Soil and/or Rock Layers .....</i>	<i>10</i>
2.3.2	Ground Water Conditions .....	11
2.3.3	Surrounding Conditions .....	12
2.3.4	Natural and Environmental Conditions.....	12
2.3.5	Geological Classification of Rocks .....	12
2.3.6	Administration and licensing.....	12
2.3.7	Management Control Factor for Engineering Projects.....	12
2.3.8	Occupational Safety and Risk Management.....	13
2.3.9	Construction Project Management Factor .....	13
2.3.10	Side Collapses Due to Design Errors.....	14
2.3.11	Errors Related to Contractors.....	14
2.3.12	Effects of Surrounding Nature .....	14
2.3.13	<i>Errors Related to the Project Manager .....</i>	<i>14</i>
<b>2.4</b>	<b>GLOBAL PROPOSED ENGINEERING TO SUPPORT THE SITE OF EXCAVATION.....</b>	<b>15</b>
<b>2.5</b>	<b>PREVIOUS STUDIES CONCERNING SIDE COLLAPSES OF EXCAVATIONS .....</b>	<b>18</b>
<b>2.6</b>	<b>CONCLUSIONS OBTAINED FROM THE ANALYSIS OF PREVIOUS STUDIES.....</b>	<b>20</b>
<b>CHAPTER THREE: METHODOLOGY .....</b>		<b>26</b>
<b>3.1</b>	<b>GENERAL .....</b>	<b>27</b>
<b>3.3</b>	<b>PRACTICAL PART .....</b>	<b>27</b>
<b>3.3</b>	<b>THE CASE STUDY.....</b>	<b>28</b>
<b>3.3</b>	<b>FIELD STUDY (QUESTIONNAIRE) .....</b>	<b>36</b>
3.3.1	Reliability .....	36
3.3.2	Research Sample Size.....	38
3.3.3	Sample Characteristics .....	38
<b>CHAPTER FOUR: RESULTS AND ANALYSES.....</b>		<b>41</b>
<b>4.1</b>	<b>DATA ANALYSIS TECHNIQUES .....</b>	<b>42</b>
<b>4.2</b>	<b>ANALYSIS OF THE QUESTIONNAIRE .....</b>	<b>44</b>

4.2.1	The Statistical Results of the Questionnaire's Axis .....	44
4.2.2	The Statistical Results of the items (statements) in Weather Axis Conditions and other Conductions Surrounding a Project .....	46
4.2.3	Axis Design Plans of a Construction Project .....	47
4.2.4	Axis Planning and following-up the methods used to protect commercial project excavations from collapse .....	49
4.2.5	Axis Quality Control and Management in Construction Projects .....	50
4.2.6	Axis Administrative Entities and Licenses related to Construction Project Excavations, especially the commercial one .....	52
4.2.7	Axis Future Plans related to related to Construction Project Excavations, especially the commercial ones, in Jordan .....	53
4.2.8	Axis Supplies of a project site before implementation (focusing on sites of commercial buildings) .....	54
4.2.9	Axis Site Reconnaissance study and other pre-studies .....	56
4.2.10	Axis Occupational Safety, Protection of Workers and Risk Management in construction Projects .....	57
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS .....		60
5.1	CONCLUSIONS .....	61
5.2	RECOMMENDATIONS .....	62
REFERENCES .....		64
APPENDIX A: SURVEY QUESTIONNAIRE.....		68
APPENDIX B: MATHEMATICAL DEFINITION .....		92

## LIST OF TABLES

TABLE 2-1: THE CLASSIFICATION SYSTEM OF SOIL PARTICLES .....	11
TABLE 3-1: THE COST BEFORE ACCIDENT.....	32
TABLE 3-2: THE COST AFTER ACCIDENT.....	33
TABLE 3-3: RELIABILITY COEFFICIENTS USING CRONBACH ALPHA FOR THE QUESTIONNAIRE.....	37
TABLE 3-4: DISTRIBUTION OF THE SAMPLE BY ORGANIZATION TYPE.....	38
TABLE 3-5: SAMPLE DISTRIBUTION BY EDUCATIONAL LEVEL .....	39
TABLE 3-6: SAMPLE DISTRIBUTION BY YEARS OF EXPERIENCE .....	39
TABLE 3-7: DISTRIBUTION OF SAMPLE BY NUMBER OF PROJECTS .....	40
TABLE 4-1: FIVE POINT LIKERT SCALE.....	42
TABLE 4-2: CRITERIA OF LEVEL OF IMPORTANCE SET FOR RESPONSES IN EACH AXIS OR ITEMS.....	43
TABLE 4-3: MEAN, STANDARD DEVIATION, RANKING AND IMPORTANCE LEVEL FOR EACH AXIS .....	44
TABLE 4-4: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE WEATHER AXIS CONDITIONS AND OTHER CONDUCTIONS SURROUNDING A PROJECT.....	46
TABLE 4-5: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS DESIGN PLANS FOR THE CONSTRUCTION PROJECT .....	47
TABLE 4-6: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS PLANNING AND FOLLOWING-UP THE METHODS USED TO PROTECT COMMERCIAL PROJECT EXCAVATIONS FROM COLLAPSE.....	49
TABLE 4-7: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS QUALITY CONTROL AND MANAGEMENT IN CONSTRUCTION PROJECTS .....	50
TABLE 4-8: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS ADMINISTRATIVE ENTITIES AND LICENSES RELATED TO CONSTRUCTION PROJECT EXCAVATIONS, ESPECIALLY THE COMMERCIAL ONES .....	52
TABLE 4-9: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS FUTURE PLANS RELATED TO RELATED TO CONSTRUCTION PROJECT EXCAVATIONS, ESPECIALLY THE COMMERCIAL ONES, IN JORDAN .....	53
TABLE 4-10: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS SUPPLIES OF A PROJECT SITE BEFORE IMPLEMENTATION (FOCUSING ON SITES OF COMMERCIAL BUILDINGS) .....	54

TABLE 4-11: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS SITE RECONNAISSANCE STUDY AND OTHER PRE-STUDIES..... 56

TABLE 4-12: RESULTS OF RESPONDENTS' INDIVIDUALS SAMPLE AXIS OCCUPATIONAL SAFETY, PROTECTION OF WORKERS AND RISK MANAGEMENT IN CONSTRUCTION PROJECTS ..... 57

## LIST OF FIGURES

FIGURE 1-1: THE HOUSING PROJECTS IN SWEILEH ( <a href="http://assabeel.net">HTTP://ASSABEEL.NET</a> ).....	5
FIGURE 1-2: DAMAGE TO THE ROAD CAUSED BY DEEP EXCAVATION FOR THE COMMERCIAL COMPLEX AT ABDULLAH GHOSHEH STREET ( <a href="http://www.royanews.tv/">HTTP://WWW.ROYANEWS.TV/</a> ).....	6
FIGURE 2-1: THE EFFECT OF TIME FACTOR COMPARED WITH OTHER FACTORS .....	23
FIGURE 2-2: THE EFFECT OF PUBLIC SAFETY MANAGEMENT COMPARED WITH OTHER FACTORS .....	24
FIGURE 2-3: THE EFFECT OF POOR MANAGEMENT OF ENGINEERING PROJECTS COMPARED WITH OTHER FACTORS .....	24
FIGURE 2-4: THE EFFECT OF WEATHER CONDITIONS COMPARED WITH OTHER FACTORS .....	25
FIGURE 3-1: A PHOTO FOR THE STUDY PROJECT .....	29
FIGURE 3-2: THE COLLAPSE OF THE SIDES OF EXCAVATIONS FOR THE STUDY PROJECT .....	30
FIGURE 3-3: PROJECT SCHEDULE IS CLARIFIED BEFORE THE ACCIDENT AND AFTER THE INCIDENT .....	31
FIGURE 3-4: CUMULATIVE COST BEFORE ACCIDENT.....	33
FIGURE 3-5: CUMULATIVE COST AFTER ACCIDENT .....	34
FIGURE 3-6: CUMULATIVE COST AFTER AND BEFORE ACCIDENT.....	35

## ABBREVIATIONS

SD	Standard Deviations
DF	Degree of Freedom
$\alpha$ -ALPHA	The significance level of the test
BH	Borehole