وزارة التعليم العالي
والبحـــث العلـمي
جامعـــــة ديـالى
كليـــة الهنـــدسة

مخلفات الهدم كمواد بديلة في أعادة الاعمار

رسالة مقدمة الى
مجلس كلية الهندسة / جامعة ديالى
وهي جزء من متطلبات نيل درجة الماجستير في علوم الهندسة المدنية

من قبل

زهراء علي جليل

بكلوريوس هندسة مدنية, 2016

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2020 م العراق 1441هـ

Ministry of Higher Education
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University of Diyala
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Demolition Wastes as Alternatives Materials in Reconstruction

A Thesis Submitted to the Council of College of Engineering, University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering

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March-2020 IRAQ Rajab-1441

Chapter One

Introduction

1.1 General

Post-disaster reconstruction has a major impact on the economies of any country in the world. Iraq is one of the countries which significantly is affected by the recent war between (2014- 2018), where terrorist acts have caused massive destruction in some areas. Therefore, the process of comes back to live of those cities needs large financial funding in addition to effective engineering management in all aspects. The reconstruction of these cities is not easy because it represents large areas containing a lot of rubble which has a negative impact on the environment. Therefore, the process of management of the rubble needs the expertise to avoid the cost of disposal and transport and also to preserve the environment from pollution.

1.2 Research Justifications

Some cities in Iraq are facing major problems due to the total destruction of large areas such as Mosul, Ramadi and Tikrit, which are the most affected cities. The reconstruction of these cities required huge money to coincide with the lack of financial customizations as a result of the economic crisis. Therefore, there is a need to provide effective management for post-disaster management to advance the reality of these cities by utilizing the available resources (Rubble) to serve the community and reduce waste and loss of those resources and to achieve sustainability through the use of these resources. Based on the information obtained from the Ministry of Planning, the most damage was done in urban cities, so it was considered that the case study should be comprehensive for all types of buildings affected.

1.3 Research Hypothesis

Based on the above-mentioned justifications, the research hypothesis assumes that it is possible to suggest an integrated framework for the management of reconstruction of destroyed cities using the remaining of concrete elements and bricks as an alternative to sand and gravel as well trying to obtain the maximum benefit from selling steel reinforcement, steel I-section, doors, and windows that extracted from waste. In the absence of any benefit from the use of concrete and broken bricks, other alternatives may be taken into consideration, which represents steel reinforcement, steel I-section, doors, and windows.

1.4 Research Aim and Objectives

The aim of the research is to find the maximum benefit from the waste of the destroyed buildings that is effective for the management of reconstruction and highlights the role of alternatives used instead of natural resources in construction projects and its impact on cost and environment. To achieve the aim of this study, the objectives are set:

1- Finding the cost reduction through the use of specific alternatives, in addition to finding its effect in reducing the total cost of concrete needed to rebuild the city.
2- Finding the difference in the results of energy analysis between construction using alternatives and construction using natural building materials.

To achieve these objectives there are four approaches:

1- Review the literature and resources relating to disasters and post-disaster reconstruction, as well as to identify alternatives that can be used in the reconstruction.
2- Collecting information related to the prices of building materials, in addition

3- Modeling a small city that actually simulates a destroyed city using BIM technology.
4- Calculate the quantity and cost of concrete needed for the reconstruction of t

1.5 Research Scope

The project was implemented in AL- Ghalibia complex in Governorate of Diyala as a case study to represent a small city, which hypothetically is destroyed and reconstructed using BIM to simulated destroyed cities in Iraq, especially Mosul, Ramadi and Tikrit cities. AL-Ghalibia complex consists of a variety of buildings: residential buildings and service buildings that include schools, medical center, market, and mosque.

1.6 Research limitations

Work within this research is restricted to the following limitations:

1- Spatial limitations:
   The research includes a case study within the Governorate of Diyala to represent a small destroyed city.
2- Temporal limitation:
   Covers the period (2018-2019) in determining the cost of building materials and recycled materials.
3- Studying effective alternatives based on traditional cost and sustainability criteria.
4- The study within the cost criterion involves calculating the results based on the total cost of concrete required for the reconstruction of the city.

1.7 Research Methodology

The research methodology includes three stages as shown in Figure 1.1:

A- Theoretical Study

Review the related literature and sources (books, engineering research, and practical studies) to:

1- Studying the concept and types of disasters.
2- Studying the methodology of post-disaster reconstruction in other countries.
3- Studying of BIM techniques and their benefits and uses in construction projects
4- Studying the methods of using recycled concrete in construction in addition to the use of crushed bricks instead of aggregate.
5- Studying the mechanical and physical properties of recycled concrete.

B- Field Study

The field study includes the prices obtained by interviewing many contractors and stakeholders in selling building materials and taking information from them in detail and this information includes:

1- The cost of natural building materials in Governorate of Diyala, which includes the cost of sand, gravel, and cement.
2- The income of selling steel reinforcement and steel I-section extracted from destroyed buildings in addition to the income of selling doors and windows.
3- The type and cost of the crusher used in the process of cracking the remaining concrete and bricks.
4- Choosing a case study and get their design schemes.

C- Practical Study

In the light of the design plans of AL- Ghalibia complex, the practical study was set as follows:

1- Modeling all buildings within the city as well as modeling reinforcing steel, doors, and windows. In addition to modeling two old residential buildings.

2- Calculation of the quantity of reinforcing steel and steel I-section and finding the income of selling it.
3- Calculate the number of doors and windows and find the income of selling them by using BIM.
4- Calculation of the quantity of concrete used in the construction of columns, floors, ceilings, and beams by using BIM.
5- Use the alternatives identified in place of natural materials and find the difference in cost using BIM technology.
6- Energy analysis of all buildings in the case of the use of alternatives and find the difference in the results of the traditional approach.

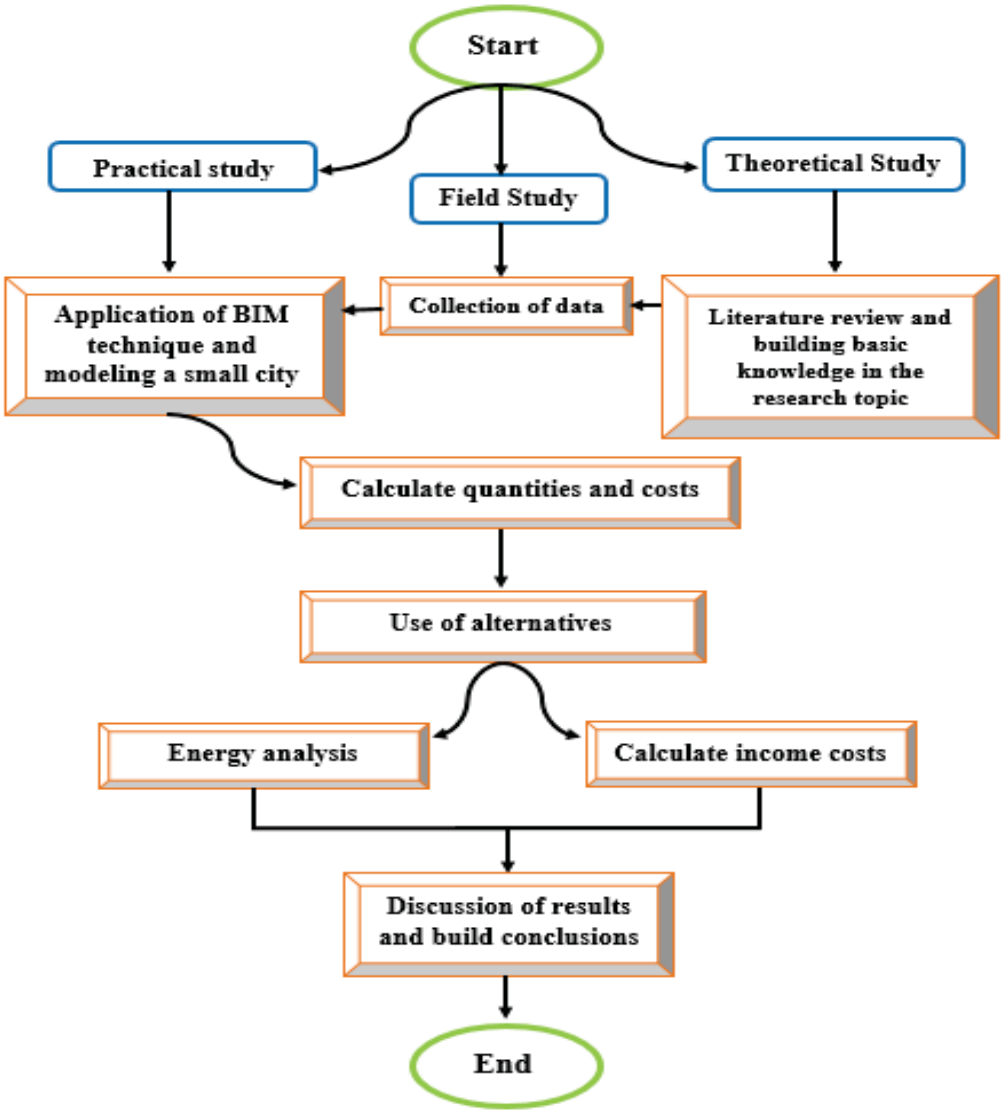

Figure 1.1 Research Methodology Flow Charts (researcher)

1.8 Research Structure

Chapter One: This chapter includes a general introduction to research, research problem, justification, hypothesis, the scope of research, theoretical study, field study, practical study, research limitations, objectives, research methodology, and thesis structure.

Chapter Two: This chapter deals with the definition of disasters, the management of post-disaster reconstruction, the structure, and methods of reconstruction. It includes the reasons for the failure of the reconstruction process in addition to the issues and challenges that may be faced in the project, beside alternatives identified and worked on during this research in addition to previous studies on the use of alternatives instead of natural materials, the definition of the technology and benefits of BIM in terms of the calculation of quantities, costs, and energy analysis.

Chapter Three: The study of specific alternatives in terms of their mechanical and physical properties. Determine the cost of natural materials and the cost of buying the appropriate crusher in addition to applying BIM in simulation reality.

Chapter Four: This chapter includes the results obtained which include calculated concrete quantities and costs in addition to the results of energy analysis.

Chapter Five: This chapter contains conclusions gained by the researcher in addition to recommendations.

Abstract

Demolition Wastes as Alternatives Materials in Reconstruction

By

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In recent years between (2014-2018), Iraq has been subjected to the most violent terrorist attack that has led to massive destruction in some cities. According to the Ministry of Planning statistic the most affected cities are Mosul, Ramadi, and Tikrit, as many buildings were destroyed in these cities, and therefore this destruction is one of the biggest disasters that Iraq has gone through. Due to the economic crisis that the country is going through at this time, this posed a greater challenge to overcome this problem, and therefore Iraq needs huge financial support for the reconstruction of those cities. In addition to the huge amount of rubble of buildings that pose a threat to the environment in the future because they need large areas to be landfill.

The aim of the research is to find the maximum benefit from the wastes of destroyed buildings and use them for post-disaster reconstruction through the adoption of effective alternatives that can be utilized to reduce the cost of reconstruction and also be effective in terms of sustainability. To achieve this aim the effective alternatives that can be used instead of natural building materials were selected from previous studies and were employed in the reconstruction by modeling a small city using Building Information Modeling (BIM) and find their impact on the cost of reconstruction and sustainability.

Alternatives represent Recycled Fine Aggregate (RFA), Recycled Coarse Aggregate (RCA) and Crushed Clay Brick Aggregate (CCBA), in

addition to reinforcing steel, steel I-section, doors, and windows extracted from the destroyed buildings. The results showed that the use of RFA instead of Natural Fine Aggregate (NFA) with replacement ratios (10% - 25% - 50% - 100%) to rebuild the ceilings, floors, and beams of all buildings can reduce the total cost of producing the concrete needed for reconstruction by (2%- 4%- 8% -16%) respectively. While the use of RCA instead of Natural Coarse Aggregate (NCA) with replacement ratios (10%- 25%- 50%- 100%) to rebuild the columns can reduce the cost of concrete production by (0.3%- 0.8%- 2%- 3.6%) Respectively. While it was found that the use of CCBA instead of NCA for the reconstruction of ceilings, floors, and beams reduces the cost of concrete production by (15%). The sale of reinforced steel and steel I-section extracted from destroyed buildings reduces the cost of producing concrete by (31%). The sale of steel doors and windows reduces the cost by rates ranging from (0.5%- 5%) depending on the proportion of steel doors and windows extracted.

The results of the sustainability criterion showed that concrete waste can be utilized and reduced in different proportions (3.8%- 9.5%- 19%- 37.9%) in the case of using crushed concrete as RFA, while concrete waste decrease by (1%- 2.4%- 4.7 %- 9.5%) in the case of using crushed concrete as RCA, and in the case of using CCBA instead of NCA, it was found that it reduces brick waste by (38.8%). The results of the energy analysis of the alternatives used in the production of recycled concrete compared to ordinary concrete have found that there is little difference between the results without causing a significant impact on energy consumption.