**T.C.**
**ISTANBUL GEDİK UNIVERSITY**
**INSTITUTE OF GRADUATE STUDIES**

# ASSESSMENT OF BUILDING INFORMATION MODELING IMPACT ON SMALL SCALE CONSTRUCTION PROJECTS

**MASTER'S THESIS**

**Ghaith Rabeea ABDULGHANI**

**Engineering Management Master in English Program**

**AUGUST 2021**

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**Thesis Advisor: Asst. Prof. Dr. Ahmet GÜLLÜ**

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**LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ**

**Yüksek Lisans Tez Onay Belgesi**

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**1) Tez Danışmanı:** Dr. Öğr. Üyesi Ahmet GÜLLÜ (İstanbul Gedik Üniversitesi)

**2) Jüri Üyesi:** Dr. Öğr. Üyesi Gökhan KAZAR (İstanbul Gedik Üniversitesi)

**3) Jüri Üyesi:** Dr. Öğr. Üyesi Hasan ÖZKAYNAK (Beykent Üniversitesi)

## DECLARATION

I, Ghaith Rabeea ABDULGHANI, do hereby declare that this thesis titled as "Assessment of Building Information Modeling Impact on Small Scale Construction Projects" is original work done by me for the award of the masters degree in the faculty of Engineering Management. I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution. (27/08/2021)

Ghaith Rabeea ABDULGHANI

## DEDICATION

***I dedicate this work***

***To my family who always supported me***

***To my friends and people I love***

**PREFACE**

I would like to express my special thanks of gratitude to every single person who have helped me to do this work, especially my thesis advisor Asst. Prof. Dr. Ahmet Gullu. I also appreciate the effort of all lecturers who taught me in my educational journey.

August 2021 Ghaith Rabeeea ABDULGHANI

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## ABBREVIATIONS

**1ST.F** : First Floor
**2D** : 2 Dimensional
**2ND.F** : Second Floor
**3D** : 3 Dimensional
**3RD.F** : Third Floor
**5D** : 5 Dimensional
**AGC** : Associated General Contractors of America
**BIM** : Building Information Modelling
**BOQ** : Bills of Quantities
**CAD** : Computer-Aided Design and Drafting
**DPC** : Damping proof concrete
**G.F** : Ground Floor
**IPD** : Integrated Project Delivery
**IQD** : Iraqi Dinar
**NBIM** : USA National Building Information Model Standard Project Committee
**QS** : Quantity Surveying

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**ASSESSMENT OF BUILDING INFORMATION MODELING IMPACT ON SMALL SCALE CONSTRUCTION PROJECTS**


## ABSTRACT

While time passes and life changes, the development of technology is taking place in every part of our life quickly, also it affects daily life. it creates new tools, procedures, and methods for all sectors, and simplifies many operations. Nowadays, design tools that depend on computers have been used in the construction industry, it has a direct effect on the whole project life, and it has made a revolution in the construction sector. Building information modeling (BIM) simply refers to the development of a building model generated by using the computer, that model is rich of data, object-oriented, smart and also a parametric digital representation of the building.

This research discusses the assessment of BIM impact for the small scale construction industry, it mainly focuses on quantity takeoff and accuracy of projects, firstly it presents the definition and the main concept of BIM. Then, a case study of a 3-storey building project in Baghdad is done to evaluate the effect of BIM quantity takeoff, tendering, and other effects on the project, Autodesk Revit 2020 software has been used to create the model of the building. The results showed that BIM can provide easy, detailed and sufficient drawings and the quantities and prices were extracted and compared with the quantities and prices that have been calculated with traditional ways, Revit calculation have reduced the total estimated cost by 4% compared to the total tender estimated cost, 6% for finishing estimated cost, and nearly no change in structure price.



**Keywords:** *Building information modeling, Cost Management, quantity takeoff.*

**KÜÇÜK ÖLÇEKLİ İNŞAAT PROJELERİNDE YAPI BİLGİ MODELLEMESİ ETKİLERİNİN DEĞERLENDİRİLMESİ**

# ÖZET

Zaman geçtikçe ve hayat değişirken teknolojinin gelişimi hayatımızın her alanında hızla yer almakta, günlük hayatı da etkilemektedir. tüm sektörler için yeni araçlar, prosedürler ve yöntemler oluşturur ve birçok işlemi basitleştirir. Günümüzde inşaat sektöründe bilgisayara bağlı tasarım araçları kullanılmaya başlanmış, tüm proje ömrüne doğrudan etki etmiş ve inşaat sektöründe bir devrim yapmıştır. Yapı bilgi modellemesi (YBM), basitçe bilgisayar kullanılarak oluşturulan bir bina modelinin geliştirilmesini ifade eder, bu model veri açısından zengin, nesne yönelimli, akıllı ve ayrıca binanın parametrik dijital bir temsilidir.

Bu Araştırma, küçük ölçekli inşaat sektörü için YBM etkisinin değerlendirilmesini tartışmakta, esas olarak projelerin miktar ve doğruluğuna odaklanmakta, öncelikle BIM'in tanımını ve ana kavramını sunmaktadır. Daha sonra, YBM metraj, ihale ve diğer etkilerin proje üzerindeki etkisini değerlendirmek için Bağdat'ta 3 katlı bir bina projesinin örnek olay incelemesi yapılmış, binanın modelini oluşturmak için Autodesk Revit 2020 yazılımı kullanılmıştır. Sonuçlar, YBM'in kolay, detaylı ve yeterli çizimler sağlayabildiğini göstermiş ve miktarlar ve fiyatlar çıkarılarak geleneksel yöntemlerle hesaplanan miktar ve fiyatlar ile karşılaştırıldığında, Revit hesaplaması toplam tahmini maliyeti toplam maliyete göre %4 oranında azaltmıştır. ihale tahmini maliyeti, bitirme tahmini maliyeti için %6 ve yapı fiyatında neredeyse hiç değişiklik yok.

**Anahtar Kelimeler:** *Yapı bilgi modellemesi, Maliyet Yönetimi, Metraj alımı*

# 1. INTRODUCTION

## 1.1 Introduction

while time passes and life changes, the development of technology is taking place in every part of our life quickly, also it effects daily life. it creates new tools, procedures, and methods for all sectors, and simplifies many operations. exceptionally, computers play the main role in every sector, in every level. In the past, Computers which were used for finding solutions for different problems (general and limited), nowadays are used to do more hard and complicated tasks, producing and analyzing different types of data. Today, design tools that depends on computers have been used in construction industry, it has a direct effect on the whole project life, and it have made a revolution in the construction sector.

Building information modeling (BIM) simply refers to the development of a building model generated by using the computer, that model is rich of data, object-oriented, smart and also a parametric digital representation of the building, which provides views, plans, and data convenient for different needs of users, it can be obtained easily and analyzed to get information that can help with making decisions and improving the operation of delivering the project (AGC, 2005).

One of the main differences between BIM 3D and 2D CAD is that 2D CAD represents the project by separated and independent drafts, such as plans, elevations and sections. When it is required to edit one of those drafts, all other drafts in the project must be checked to see the effect of editing on them, that process usually causes many faults and interactions between drafts, and quantities must be also checked. In addition, in 2D drafts, data are graphical elements only, such as lines, rectangles, arcs and circles, while in 3D BIM models, objects are smart elements and defined as walls, beams, columns, and slabs (CRC Construction Innovation, 2007).

## 1.2 Problem Statement

Stakeholders are seeking to achieve mainly 3 goals in every project they want to publish, these goals are low cost, short time, and high quality. Most of the errors that occurs during the construction period are due to interferes in the drawings, for example the interferes between architectural and structural drawings, or miss-understanding of those drawings. That may cause change orders during construction period, and hence it will cause increasing in the expected time and the cost of the project, some of those errors can be totally corrected, but other errors will leave some bad impress in the construction and cannot solved 100%, and of course that will be considered as a reduction in quality. In addition, some stakeholders still have problems in quantity surveying, when it is calculated less than the actual quantity it will cause increasing of the estimated cost of the project, traditional methods for calculation are not accurate, also it takes several days for preparing it.

BIM creates a model for the whole project, which will reduce the errors, all interferes can be corrected during design phase and that will save time and cost also it may keep the quality up. For QS BIM can generate quantity schedules automatically without using other programs, also it is supposed to be more accurate than traditional methods.

## 1.3 Objective and Aim of Research

The main purpose of this research is to evaluate the impact of implementation BIM technology on small scale projects, trying to solve drawings interferes and missing drawings problems. The research will mainly focus on QS and cost management of the project. A case study will be applied for an existing 3 story building, it will be Re-designed by a BIM software (Autodesk Revit 2020), the quantities will be re calculated and the results will be discussed. This thesis aims to redirect the attention and increase the awareness of companies that deals with small projects.

### 1.4 Organization of Thesis

this research contains Five chapters, it is organized as the following:

chapter one "introduction" it contains an introduction of the research, it explains the statement of the problem, objective and aim of research, and finally research organization (structure of research).

Chapter two "literature review" this chapter shows the literature part of the thesis, it contains a background about BIM, definition of BIM, historical development, the softwares used, adoption and application of BIM.

Chapter three "case study" this chapter includes introduction describes the case study, reasons and barriers behind choosing the case study, and creating the 3 – D model of the building using Autodesk Revit software.

Chapter four "Results and discussion" this chapter deals with extracting drawings, preparing bills of quantities from Autodesk Revit software, comparing schedules, and discussion of the results.

Chapter five "conclusion" this chapter introduces the conclusions of the thesis, future studies will also be discussed.

# 2. LITERATURE REVIEW

## 2.1 Building Information Modeling (BIM)

The emerging of building information modelling (BIM) gives opportunities to penetrate the limitations of traditional buildings like weary modeling, model conflicts, and high cost implementation, and supports BIM into the process of digital building design.

Building information modeling methodology is one of the most current in building & construction sector. It is a merged system which contains everything relative to the project and place it in one template. It is appreciated as a main data base which provides all project parts and it has project documents, whether they were plans, quantity schedules, or time tables for the applying of project work. It provides users with accurate, coordinated and available information during the project phases and collects the necessary functions to complete the building through an electronic virtual model that simulates reality. These systems have become widely used by the parties to the project during its life cycle, such as owners, designers, contractors and project managers

For allowing the thesis to achieve it's objective, BIM concept must be prehended very well. Therefore, deep research on BIM should be provided in this part of the thesis.

## 2.2 Definition of BIM

The Associated General Contractors of America (AGC) defined BIM as the following: "Building Information Modelling (BIM) is the development and use of a computer software model to simulate the construction and operation of a facility". The resulted model which is a building information model, is rich of data, intelligent, object-oriented and provides a parametric digital representation of the project, which provides data that is convenient to different users' needs. BIM technology can also be used to obtain and analyze information to enhance decision making and the process of delivering the facility. USA National Building Information Model Standard Project Committee (NBIM) provides the following definition: " Building Information Modeling (BIM) is a digital representative of the physical and functional properties of a plant. BIM is a common information source which creates a reliable basic for the decisions being taken for a plant during its lifecycle; is valid starting from the decision for the construction until the end of the demolition (NBIMS, 2016)".

## 2.3 Historical Development of BIM

During the past decades, construction sector increased the interest in using two-dimensional building information models (2D-BIM), because it has many benefits during design phase, planning phase and during the construction of new buildings. The development of 3D modeling began in the 1970s, related with the early computer-based design (CAD) which covered several industries. At the time that many industries provided integrated analysis tools and object-based parametric modeling (which is being the basic concept of BIM), construction sector took a lot of time to the conventional 2D design. BIM modeling was implemented in empiricist projects in the early 2000s. In order to enhance building design of engineers and architects. The major research trends focused on enhancement of design, planning, interference detection, 3-D visualization, bills of quantities, cost and data management. After a while, specialized tools of design for architecture and engineering major joined the basic implementation, such as structural analysis, energy analysis, scheduling and progress tracking. The use of BIM focuses on pre-planning, design, construction and integrated project delivery of buildings and other facilities, however lately, researches focus expands from the stage of earlier life cycle (LC) stages to maintenance, deconstruction, refurbishment, and end-of-life concepts especially in complex structures.

## 2.4 How BIM Used

According to some recent surveys, building information modelling BIM is adequate for big scale and complex buildings and used by the respondents those surveys in residential, commercial, , educational, healthcare and many other building types. Because of that less than 10% of the respondents are owners, facility managers, or deconstructors, these trends do not necessarily represent the current use of BIM in existing buildings. Despite the fact that BIM application needs deep process changes of the implicated parties, in new construction projects of both private and institutional owners, the benefits are diversified and often being satisfied the involved stakeholders. Major benefits consist in design consistency and visualization, cost estimations, clash detection, implementation of lean construction or improved stakeholder collaboration. Major challenges in new buildings refer to change from design bid- build processes to integrated project delivery (IPD) and to the increased time effort and knowledge required for BIM use. However, BIM application in existing buildings stand up for other qualifications and challenges. Prospective advantages of using BIM in FM tend to be very worthy e.g., as valuable ‘as-built’ (heritage) documentation, maintenance of warranty and service information quality control, assessment and monitoring, energy and space management, emergency management, or retrofit planning. Decontamination or deconstruction processes could also benefit from structured up-to-date building information to reduce errors and financial risk, e.g., through deconstruction scheduling and sequencing, cost calculation, rubble management, optimization of deconstruction progress tracking or data management. many types of information are important to manage a facility or to proceed retrofit measures in buildings.

## 2.5 Programs Used BIM Technology

There are many Building Information Tools available in the software market. Some of the BIM tools are listed in the table below. In Table 2.1 Mechanical, Electrical, Plumbing, Structural, Architectural and Site Work 3D modeling software programs are listed

**Table 2.1:** BIM Tools

| Product Name | Manufacturer | Primary Function |
|---|---|---|
| Cadpipe HVAC | AEC Design group | 3D HVAC Modeling |
| Revit Architecture | Autodesk | 3D Architectural Modelling and parametric design |
| AutoCAD Architecture | Autodesk | 3D Architectural Modelling and parametric design |
| Revit structure | Autodesk | 3D structure Modelling and parametric design |
| Revit MEP | Autodesk | 3D Detailed MEP Modelling |
| AutoCAD Civil 3D | Autodesk | Site Development |
| Cadpipe commercial pipe | AEC Design Group | 3D pipe Modelling |
| Dprofiler | Beck Technology | 3D Conceptual modelling with real time cost estimating |
| Bently BIM suite (Micro station, Bently Architecture, Structural, Mechanical, Electrical, Generetive Design) | Bently Systems | 3D Architectural, Structural, Mechanical, Electrical and Generative components Modeling |
| Fastrak | CSC (UK) | 3D Structural Modelling |
| SDS/2 | Design Data | 3D Detailed Structural Modelling |
| Fabrication for AutoCAD MEP | East Coast CAD/CAM | 3D Detailed MEP Modelling |
| Digital Project | Gehry Technologies | CATIA based BIM system for Architectural, Design, Engineering and Construction Modelling |
| Digital Project MEP System Routing | Gehry Technologies | MEP Design |
| ArchiCAD | Graphisoft | 3D Architectural Modelling |
| MEP Modeler | Graphisoft | 3D MEP Modelling |
| hydraCAD | Hydratec | 3D Fire Sprinkler Design and Modelling |
| AutoSPRINK VR | M.E.P. CAD | 3D Fire Sprinkler Design and Modelling |
| FireCAD | Mc4 Software | Fire piping Network Design and Modelling |
| CAD-Duct | Micro Application | 3D Detailed MEP Modelling |
| Vectorworks Designer | Nemetschek | 3D architectural Modelling |
| Duct Designer 3D, Pipe Designer 3D | QuickPen Internation | 3D Detailed MEP Mdelling |
| RISA | RISA Technologies | Full suite 2D and 3D structural design Applications |
| Tekla structure | Tekla | 3D Detailed Structural Modelling |
| Affinity | Trelligence | 3D Model Applications for Early Concept Design |
| Vico Office | Vico Software | 5D Modelling Which can be used to generate cost and schedule data |
| Power Civil | Bently systems | Site Development |
| Site Design, Site Planning | Eagle Poing | Site Development |

There are number of BIM software for scheduling, clash detection, coordination and planning of the construction projects. Some of the BIM software's are listed in Table

2.2 and their use are brie y explained. There are also integration programs such as Innovaya and Synchor. These integration programs are a bridge between the 3D model of the project and the scheduling programs (MS Project, Primavera). In addition, Vico is powerful BIM software which has tools for 5D modeling.

**Table 2.2:** BIM Construction Management Tools

| Product Name | Manufacture | BIM Use |
|---|---|---|
| Navisworks Manage,<br>Navisworks scheduling | Autodesk | Clash Detection scheduling |
| Project wise | Bently | Clash Detection scheduling |
| Digital Project Designer<br>Visual Simulation | Gehry Technologies<br>Innovaya | Model Coordination<br>Scheduling |
| Solibri Model Checker | Solibri | Spatial Coordination |
| Synchro<br>Tekla Structures | Synchro Ltd.<br>Tekla | Planning & Scheduling<br>Structure-centric Model Schedule Driven Link |
| Vico Office | Vico Software | Coordinate Scheduling Estimation |

### 2.6 The Most Used Programs in the Sector

A survey undertaked by Burcin and Samara, 2010, of 424 construction indicates that different BIM tools have already been adopted in construction industry. Figure 2.1 states the market portion of different BIM tools which are used by those 424 constructions. Autodesk BIM tools are the most widely used BIM solutions in U.S with 54% of those construction using them; Graphisoft Archi CADTM follows with 10.7% and Bentley BIM tools with 8%. Tekla and Vico BIM tools are utilized by 6.5% and 5.8% of the construction based on the survey. The other software tools such as Innovaya TM, Dprofiler TM, Vectorworks TM, etc. are also being utilized by a small portion of the construction. The software tools have been used in different phases during the project lifecycle such as Preliminary Design and Feasibility Study, Shop Drawing and Fabrication, Estimating, Scheduling, and File Sharing & Collaboration. The purchase of the software package is different from regular purchases, since the buyers need to consider the capabilities of each software tool in the package. This section provides general information about BIM software packages which are widely adopted by users.

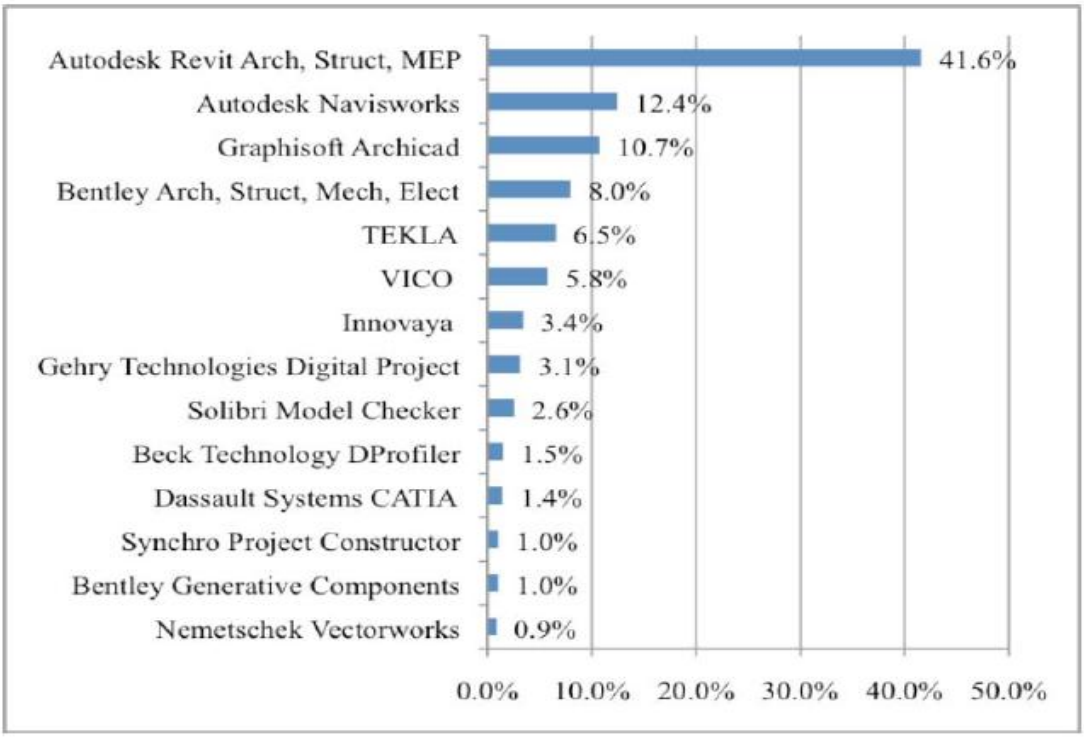



**Figure 2.1:** Ratios of Market Share of BIM Tools Which are used by Construction Firms

## 2.7 Adoption of BIM In Construction Projects

There are different degrees of development and in some countries, it is mandatory and BIM guidelines are available (Figure 2.2), whereas in others BIM is not promoted. Over the past six to seven years many pilots and live projects have been completed and documented in Finland, USA, Denmark, Singapore, and UK, which demonstrated the capability of using BIM within the construction process facilitating construction lifecycle. Many ongoing projects have been proven to develop more environmentally sustainable products, compared to non-BIM based projects. The present situation of Turkey, Australia, Canada, China, Denmark, Estonia, Finland, Germany, Hong Kong, Iceland, India, Ireland, Italy, Netherlands, New Zealand, Nigeria, Norway, Singapore, South Korea, Spain, Sweden, Taiwan, United Arab Emirates, United Kingdom and USA is described below. Moreover, the limitations and possibilities of BIM development in public contexts are discussed.

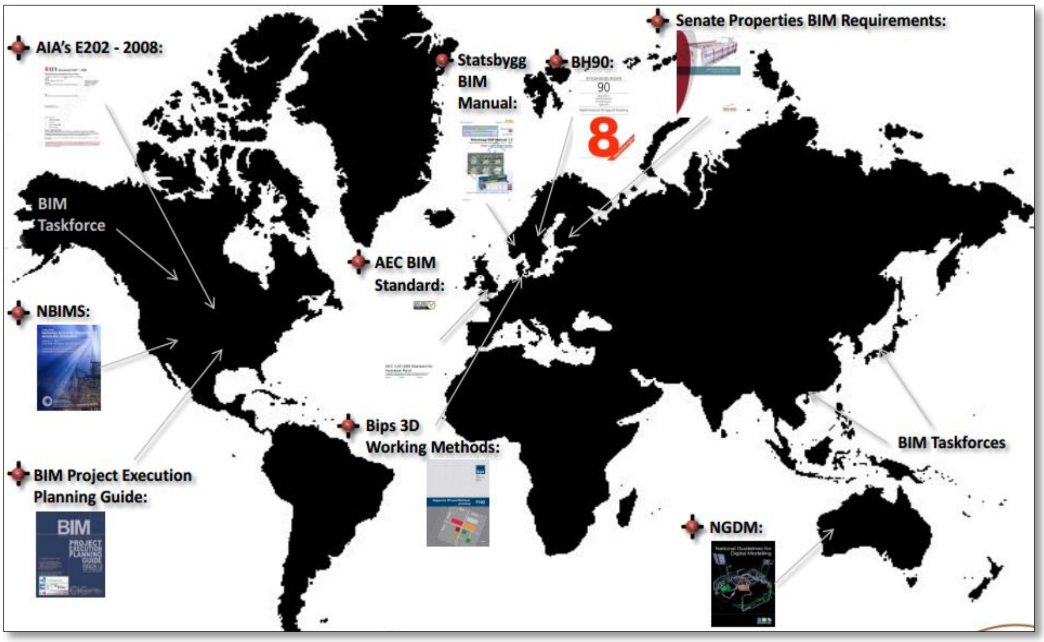



**Figure 2.2:** Worldwide BIM Adoption Levels.

### 2.8 Benefits of Building Information Modeling (BIM)

- 3-D visualization: Architectural 3-D rendering can be easily made with BIM.
- Shop drawings generating: shop drawings can be quickly and easily generated for different plans, sections and other parameters.
- Maintenance of buildings: BIM can be applied for renovation and maintenance of buildings.
- Material and cost estimating: Materials and cost estimating can be done with BIM softwares automatically and very quickly. In addition, when changing any part of the model, materials extracted and changed immediately.
- Interference detection: It is one of the most useful features of BIM. To make certain that no elements intersect with each other, all main systems and elements can be visually checked for interference.
- Structural Analytical model: Since BIM-based model has intelligent objects, it can be exported to other analytical softwares, for example, Autodesk Revit has analytical model feature.

- Reducing the time of project delivery: Stanford University center for integrated facilities engineering (CIFE) indicates that BIM can reduce project time up to 7%.
- Team work-friendly: Some BIM softwares like Autodesk Revit have the feature of “work set” which allows different users to have the access to the same model and also edit it if they have been given the authority to. however, every edit is recorded according to the user who has made it. This can help architects, structural, mechanical, and electrical designers to work in one platform, and that can save time and minimize the conflicts.

# 3. CASE STUDY

## 3.1 About case study

The case study which was selected is a 3-storey building located in south Baghdad, it consists of small shops and residential flats.

The project can be summarized by the following: -

The total area of the land was (535m2) while actual construction area of the ground floor was (476m2)

Ground floor includes 6 small shops and 3 residential flats.

The first floor includes 4 residential flats with balconies, with a total area of (476m2).

The second floor is completely typical with the first floor.

The land is located in a corner of 2 streets (main street and branch street).

Third floor is a service floor includes a small store and a space with access to the roof, the total area is (59m2).

The building has one entrance (for the flats) without elevator.

The construction system is a concrete column-girder-slab, with non-bearing walls.

The project was assigned to a local contracting company, the estimated cost was 679942000 IQD.

## 3.2 Reasons behind Choosing the Case Study

1. The project is belongs to the private sector and owned by individual person (investor).
2. That type of buildings is very common and plenty of buildings have a similar design and contracting concept in that Area.

3. Many documents are missing due to transferring from architect to the owner and then to the contractor.
4. It contains small and narrow areas of rooms and facilities which are generally consist of plenty of conflicts.

### 3.3 Barriers of the Case study

The project designs that were obtained from the contractor (which were sent by mail in pdf. and dwg. Format) was not clear and a lot of documents are missing.

The other documents of the project (BOQ and the actual quantities) were given but it covers only some parts of the project, some parts are left as a blank in the tables, other information are not even mentioned.

The structural designs were missing, however only the diameters of bars, spacing and grade of concrete was mentioned in the BOQ.

The project didn’t start yet, so the actual quantities of the building is not available, also errors and conflicts are not available.

These barriers are common in a lot of projects, and therefore the need of another solution is increasing, one of these solutions is the implementation of building information modelling (BIM).

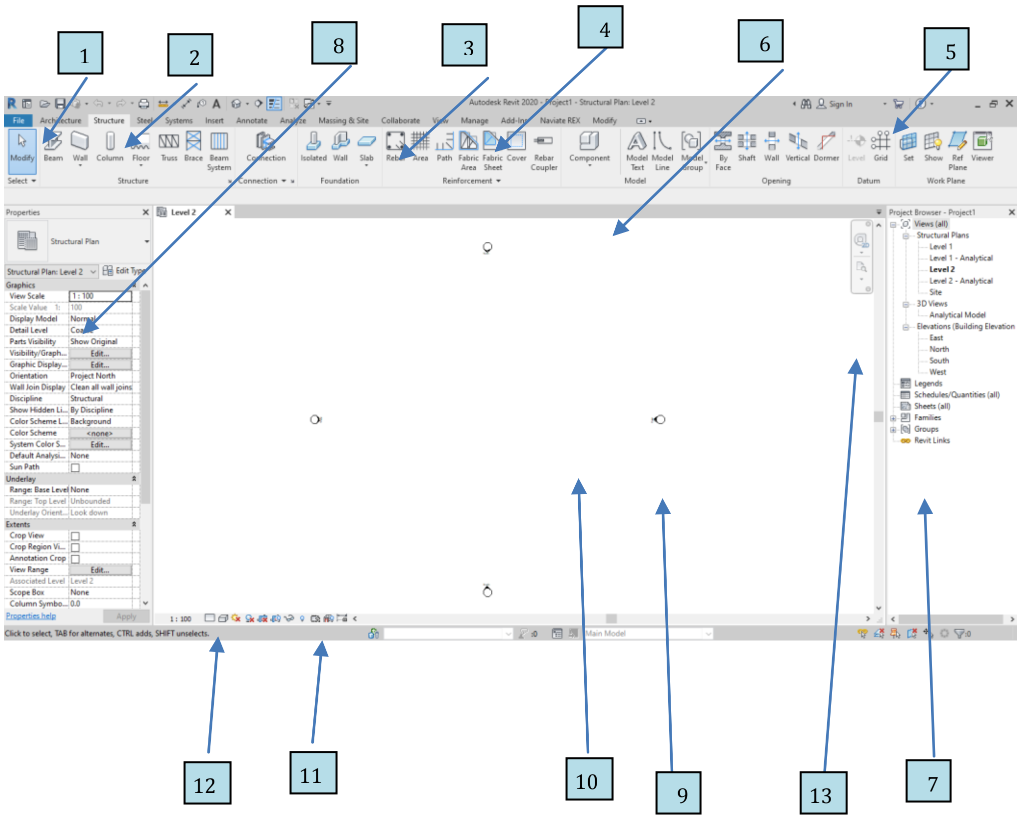
### 3.4 Creating the 3D Model of the Case Study Using Autodesk Revit Program

Data obtained from the contracting company were 2-D drawings created by AutoCAD program, and Tender contains bills of quantities with some information. however, the Drawings were very simple and lack for data required to deal with it, also some necessary drawings are missing.

In this section, Data-rich building information model will be created according to those drawings and information provided in the BOQ. Creation of model will start with creating grids and axes, raft foundation, columns, slabs, stairs, steel rebars, walls, doors, windows, and finishes.

### 3.4.1 User interface

The interface of Autodesk Revit program is very simple, easy and understandable for all kind of users, it consists of many categories which appears just after opening new or existing project, those categories are collected together to provide the users with the needed tools to create the building information model, the user interface simply consist of Application Menu, Quick access toolbar, Ribbon: tabs, Ribbon: Tools, info center, option bar, project browser, properties, elevation tag, drawing window, status bar, view control bar, and navigation bar.




1Application Menu
2 Quick access toolbar
3 Ribbon: tabs
4 Ribbon: Tools
5 info center
6 option bar
7 project browser
8 properties
9 elevation tag
10 drawing window
11 status bar
12 view control bar
13 navigation bar

**Figure 3.1:** User Interface

### 3.4.2 Creating axes and grids

After opening structural template, units have been fitted, 10 vertical, 6 horizontal axes, and 7 levels has been created. Axes can be locked to avoid moving it by mistake, also some categories like columns or walls can be linked to it, levels are created according to top level of blinding, foundation, and floor slabs.

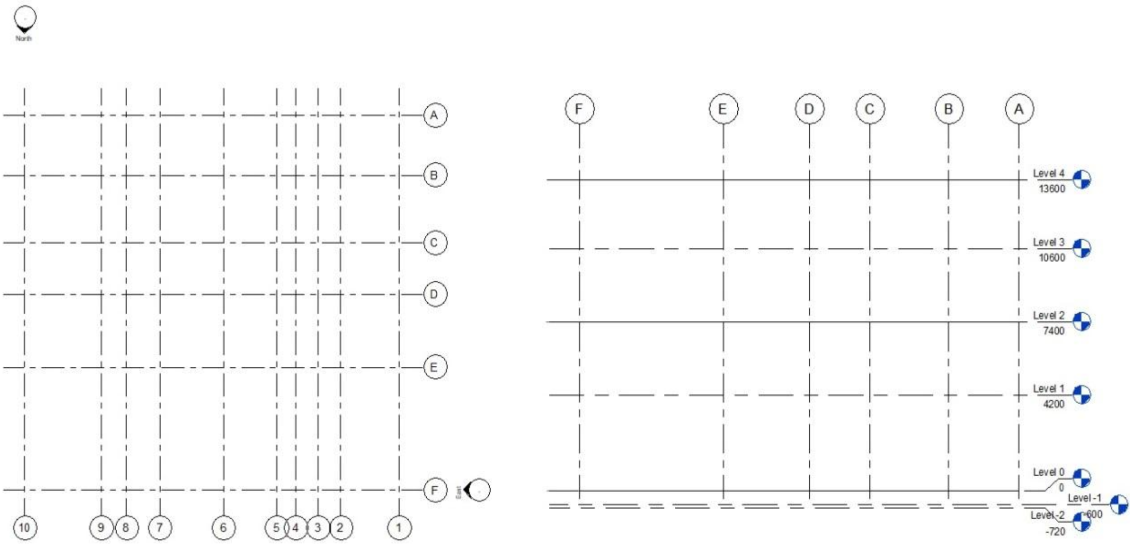



**Figure 3.2:** Grids and Levels

### 3.4.3 Creating Raft foundation

A 12 cm concrete blinding was applied for the whole land area, also Raft foundation with thickness of 60 cm was created within the building area, two layers reinforcement was also placed with diameter of 16mm and spacing of 250 mm, both layers, each direction. Reinforcement was created automatically with "Area reinforcement" tool, only by simple steps, like determining the borders of reinforcement area, number of layers, number of directions, hooks, bar diameters and spacings.

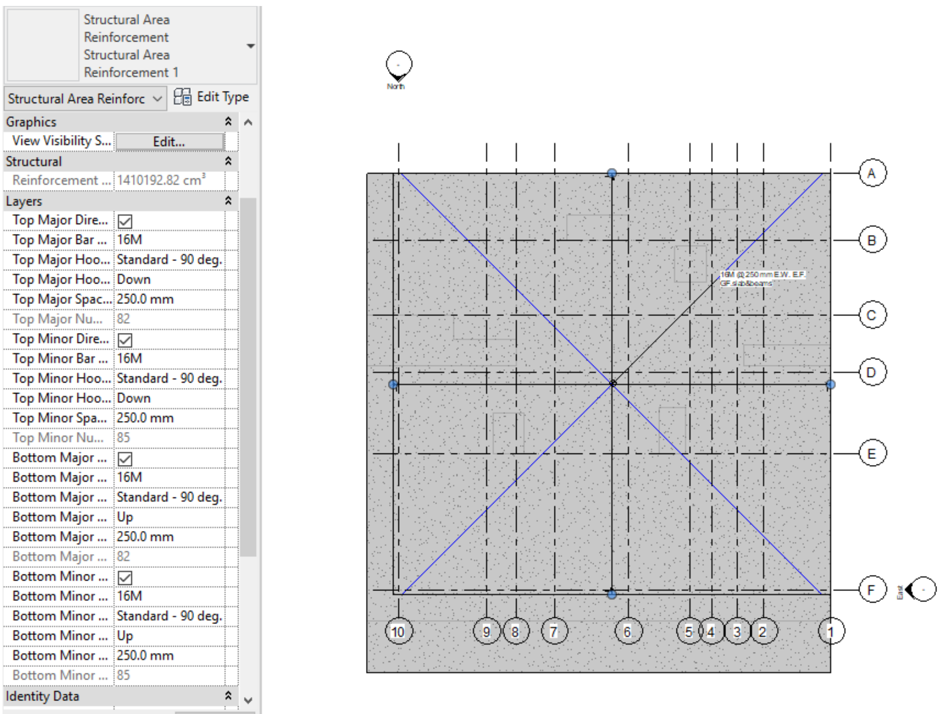



**Figure 3.3:** Blinding and Reinforced Raft Foundation

### 3.4.4 Creating columns

Total number of columns is 131 columns in this project was rectangular with dimensions of (300*600). however, 2 columns were (300*300), ground floor consists of 41 columns, first and second floor consist of 80 columns (40 for each floor), and the last floor had 10 columns.

After placement of columns, steel reinforcement have been placed using special extension “Naviate REX”, this extension allows users to create reinforcement for different kinds of structural members by entering bar diameter, number of bars, stirrups diameter and distribution and type of end-bending, also dowels length can be determined. steel Reinforcement was placed with the same amount as mentioned in BOQ that was given by the company.

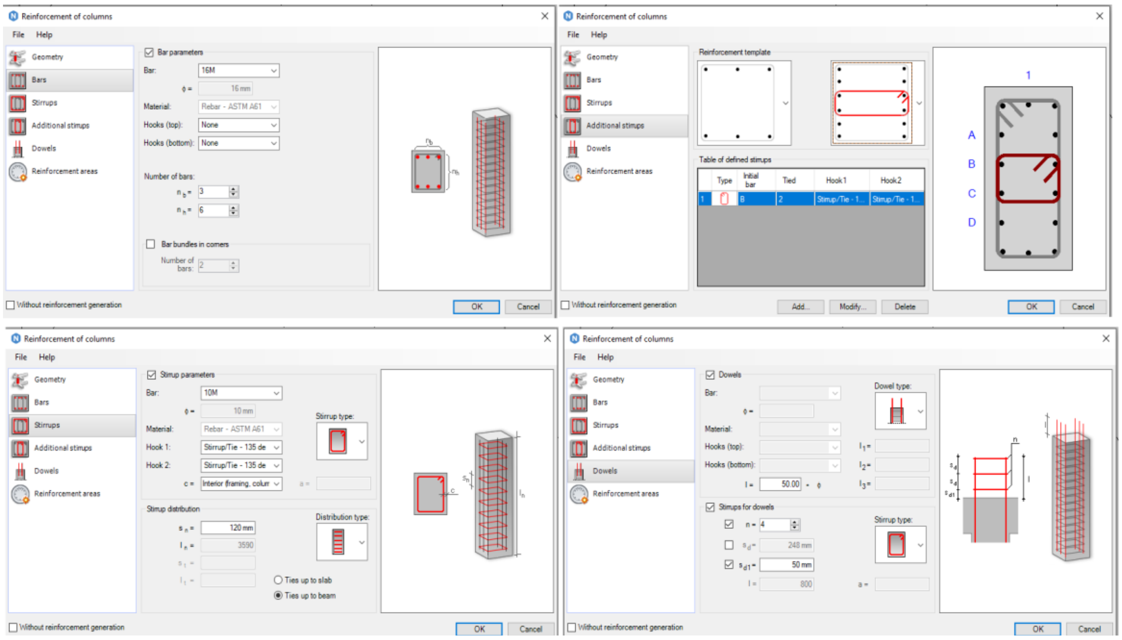



**Figure 3.4:** Placement of Steel Rebars for Columns

### 3.4.5 Creating beams

Beams had been created by selecting structural concrete beams with dimensions of (300*600mm) for the main beams, inverted beams was (200*400mm) for balcony parapets, also beams of the roof was (300*800mm) as a the top 200mm was considered as a parapet. Fig (3.5) shows the structure of the building after placement of beams.

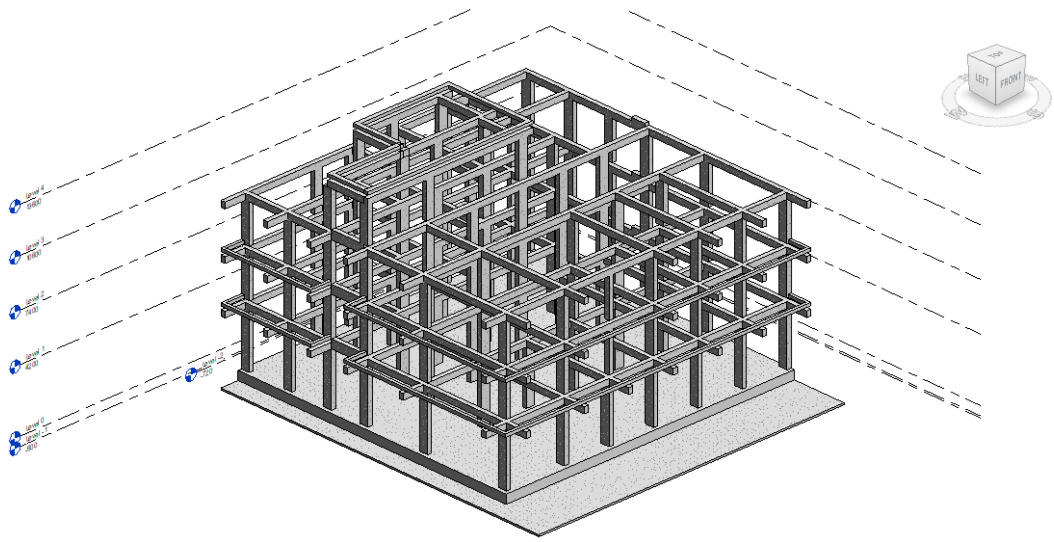


**Figure 3.5:** Structure of the Building after Placement of Beams

After creating of beams, steel rebars was placed, with the use of “naviate REX” extension which was mentioned before. Fig (3.6) shows the placement of steel rebars for beams.

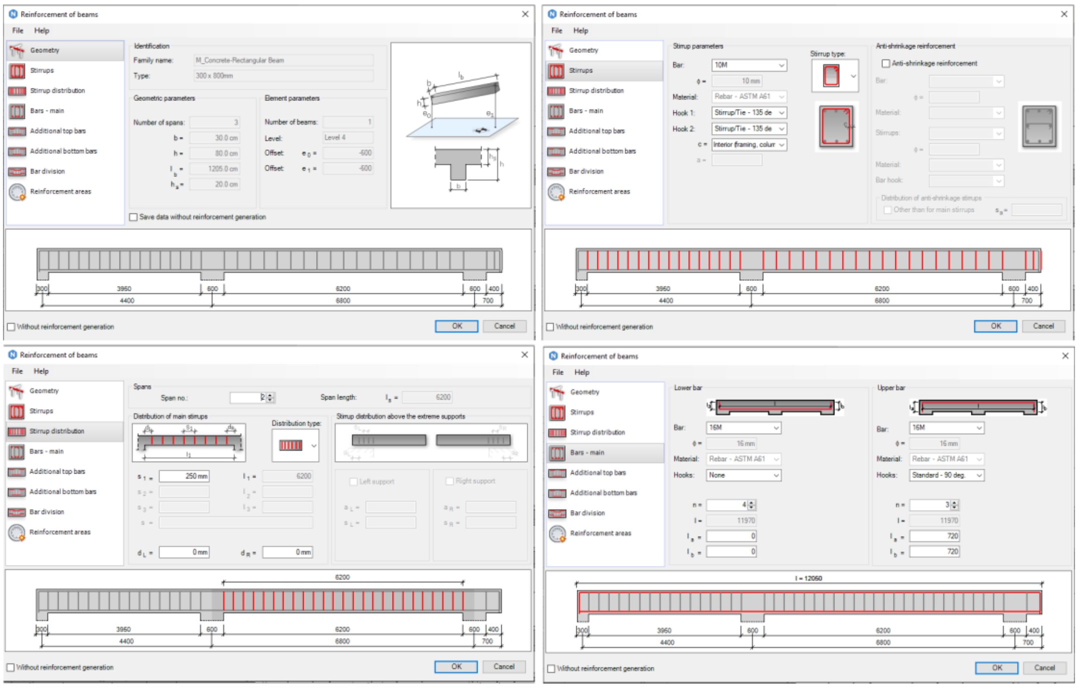


**Figure 3.6:** Placement of Steel Rebars For Beams

### 3.4.6 Creating slabs

A 20 cm thickness concrete slabs were created for level 1,2,3 and 4, level 1,2 and 3 were typical slabs while level 4 was different slab area. Fig (3.7) shows the building’s structure after creating slabs.

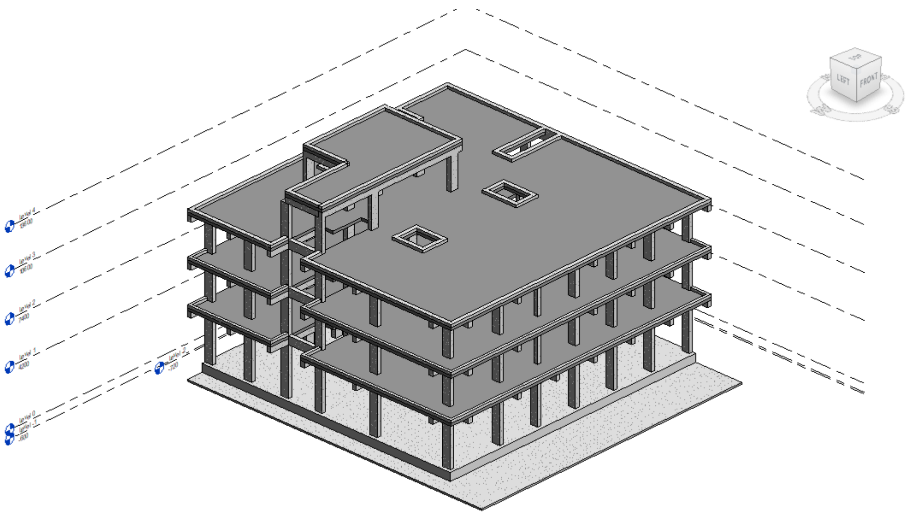


**Figure 3.7:** Building's Structure After Creating Slabs

After that, steel reinforcement had been placed by using "structural area reinforcement" tool, as mentioned in BOQ floor reinforcement details was: two layers 12mm rebars with spacing of 200mm each direction. Fig (3.8) shows the reinforcement of floors.

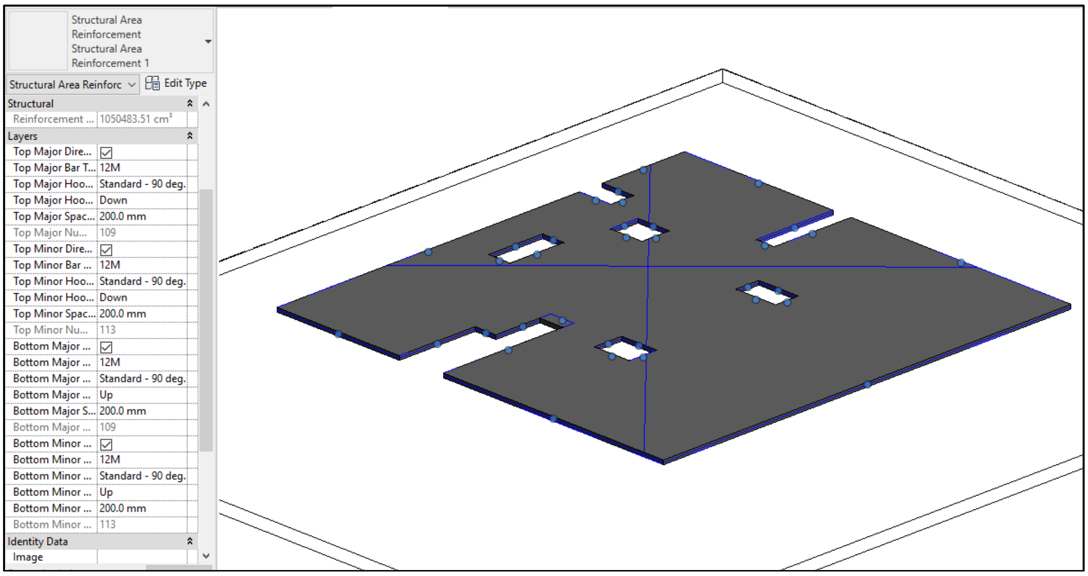



**Figure 3.8:** Reinforcement of Floors

one of the advantages to mention is that when floors created, Revit program have recognized it as a structural member not just a shape, therefore the intersection between slab and beams was taken into consideration, slab and beams was automatically joined, so that the intersection volume will not be calculated twice in any type of calculation like quantity schedules, this is one of the benefits of using building information modeling.

### 3.4.7 Creating stairs

As the building had 3 floors, it contains 3 stairs, the stair from level 0 to level 1 was different in number of rises from the other 2 stairs because of the difference of height between levels.

While creating stairs, railings was automatically placed to fit the stair, the profile of railings can also be edited.

After creating stairs, steel reinforcement was placed using 12mm rebars with 120mm spacing. Fig (3.9) shows the stairs connecting between floors.

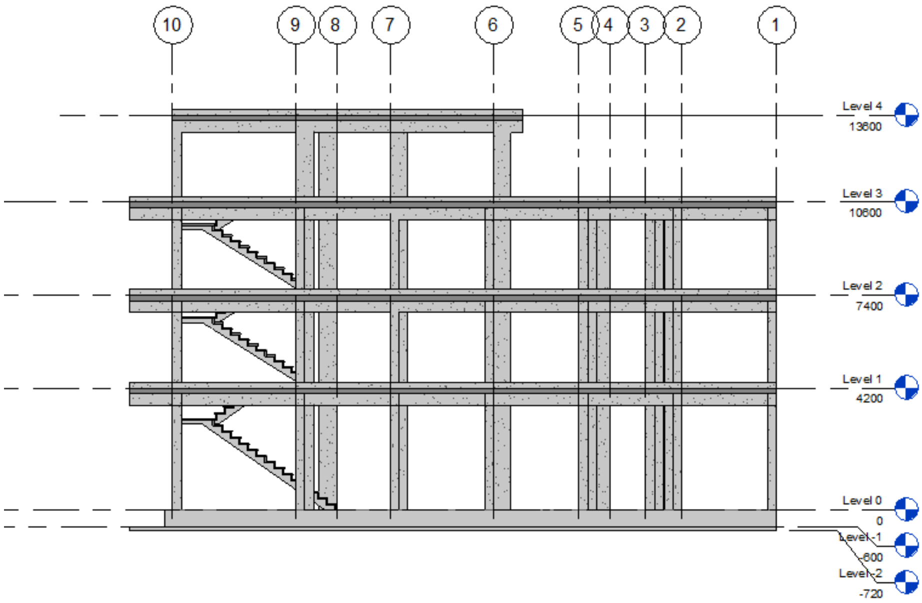



**Figure 3.9:** Stairs Connecting Between Floors

### 3.4.8 Creating walls

Walls with thickness of 25 and 12 cm was placed in the proper locations and directions, while creating the core of the walls, finishing layers with different materials and thicknesses was added to the wall cores so that it will simulate it and take it into consideration wile extracting material takeoff schedules.

The height of ground floor's walls was 3.85m in the places without beams and 3.45m in the places located under the beams, while in the first and second floor (level 1 and 2) it was 3m up to the bottom of the roof and 2.6 up to the bottom of the beams. in the last floor (level 3) it was 2.8 up to the bottom of the roof and 2.4 up to the bottom of the beams. Fig (3.10) shows the building after creating walls, doors and windows.

After creating walls, windows with different types were placed to the walls, each type created separately and the values of width, height and sill height was entered, after that by selecting the required type and click on the required place of the wall from level 0,1,2 or 3 the window can be placed.

Doors were also placed in the same way of window placing, from architect/ door, then select or create the type, the width and height is entered in each type, (900x2200), (1000x2200), (1100x2700), and (2000x2700) mm.

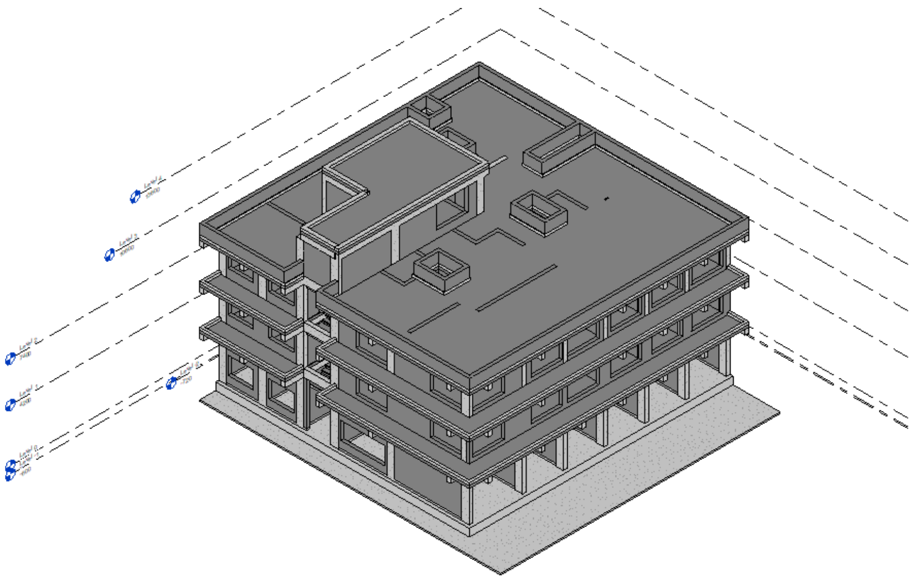


**Figure 3.10:** The Building After Creating Walls, Doors and Windows

### 3.4.9 Creating finishes

Some finishes of the building were placed with walls as layers including plastering, gypsum plastering, ceramic, paint, facade sweep, and facade marble. The rest finishing materials were placed by placing material as paint to the required faces like beams or columns so that in schedules it can calculate the paint area of that material. Also, by using "Room & Area" features it gives the area and perimeter of each room closed by 4 walls, the name of every room was given so that it can be used in scheduling by sorting and filtering the rooms by name, it helps scheduling roof gypsum plaster of rooms, paint, floor tiles, skirting, and roof isolation.

## 4. RESULTS AND DISCUSSIONS

After creating the model depending on the information and

### 4.1 Extracting Drawings

The drawings given by the company was lacking for information, also some necessary drawings were missing. In this part, drawings like floor plans, elevation views, and sections have been provided.

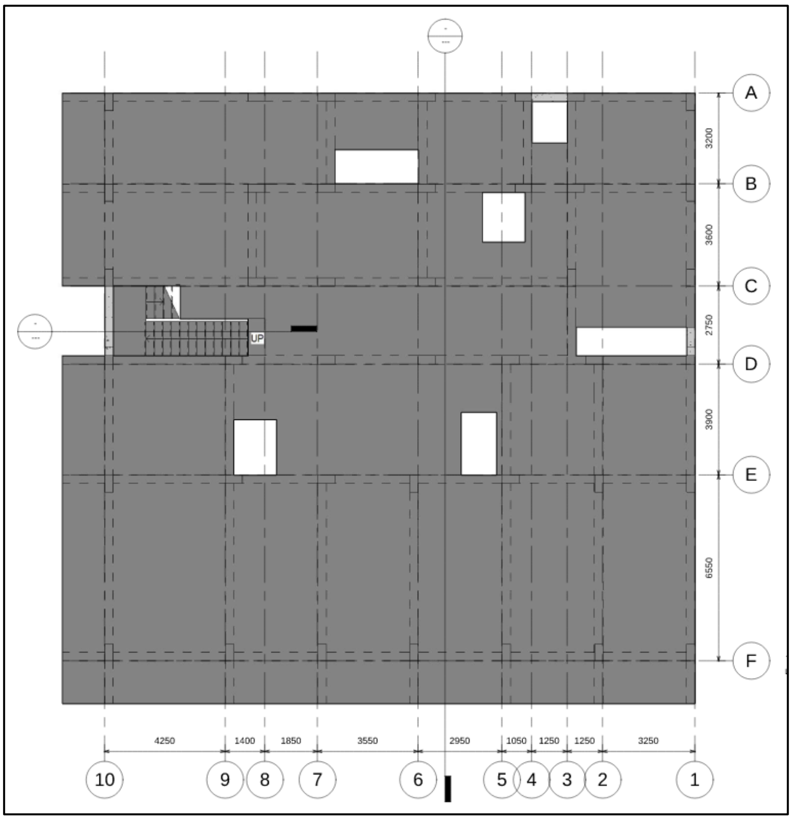



**Figure 4.1:** Structural Drawing For Level 0 (Ground Floor)

*Structural drawings for each level.*

Structural drawings, which include floors, stairs, columns and beam's locations, can be extracted from Revit program easily by just selecting the required level and editing the visibility and graphics from properties to filter drawing's categories, also from properties, the view range might need to be edited to view some required details. Figure (4.1), (4.2) and (4.3) shows the structural drawings for ground, first, second, and third floor respectively.

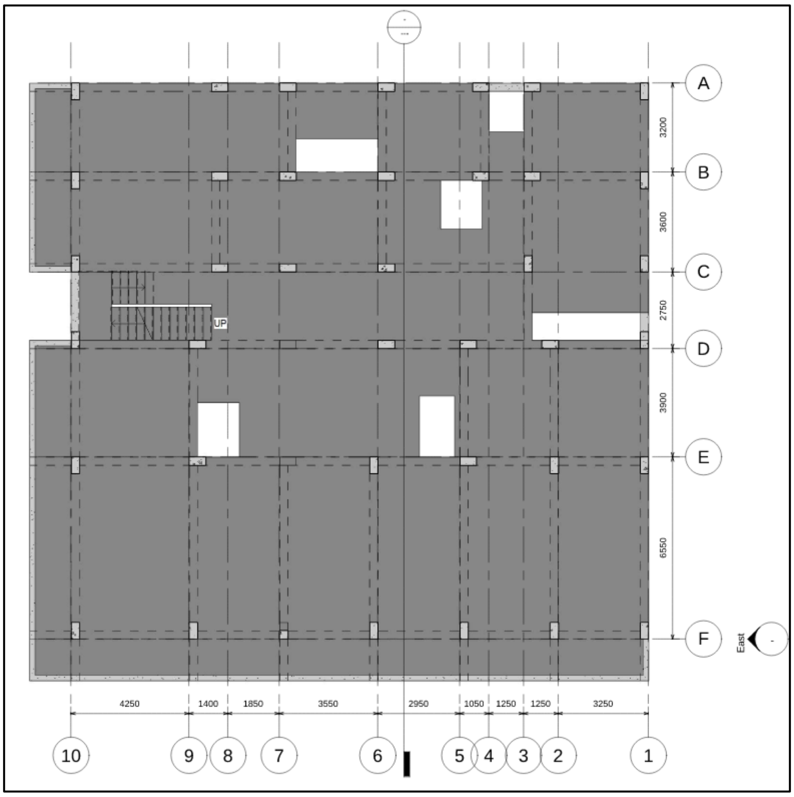



**Figure 4.2:** Structural Drawing For Level 1 and 2 (First and Second Floor)

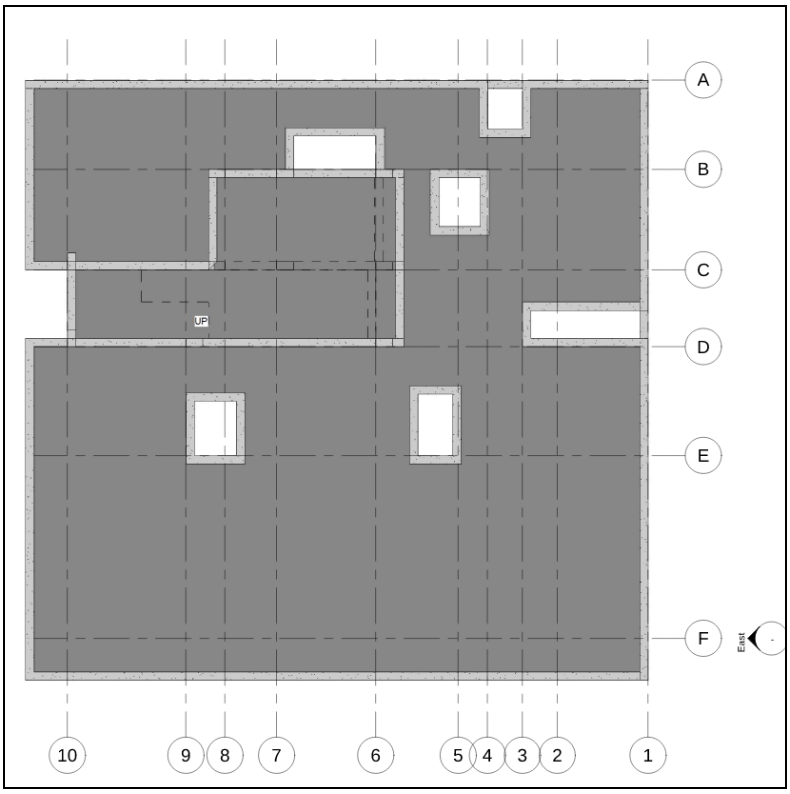



**Figure 4.3:** Structural Drawing For Level 3 (Third Floor)

Side views of the structure are also important to understand the structural drawing's concept deeply. In the Cad – based drawings that have been provided with the project documents, no side views or sections are provided. In Revit program, side views from north, east, south, and west are automatically created without having to draw them, figure (4.4) shows the lateral side views of the building from 4 sides.

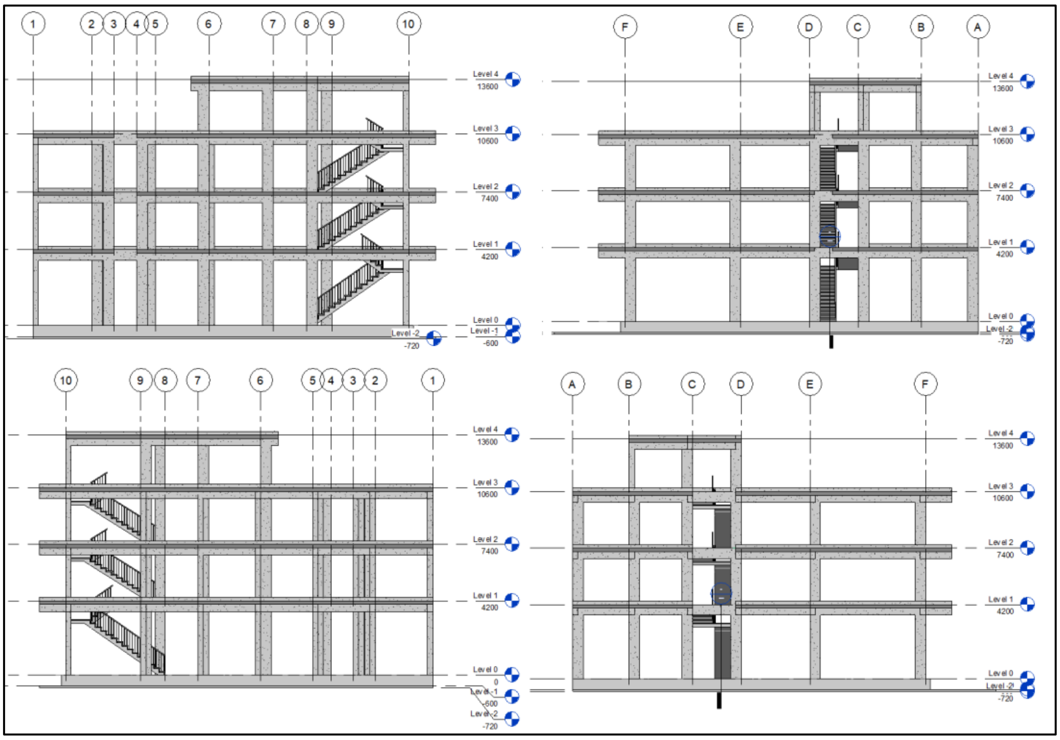


**Figure 4.4:** Structural Side Views of the Building

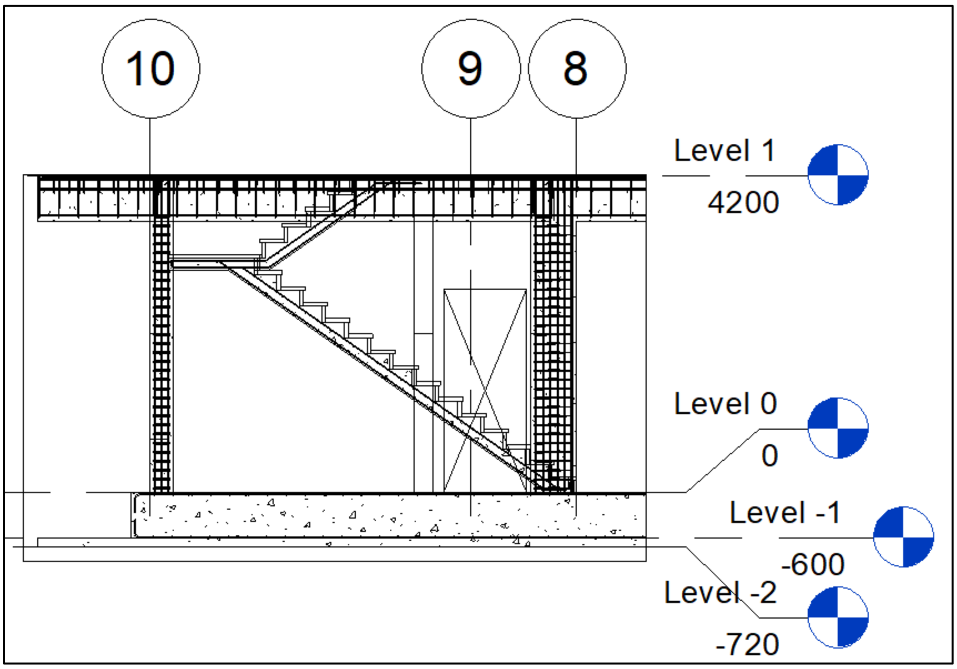



**Figure 4.5:** Cross Section For Stair Details

Sections can also be provided for any plan in the view, from view/ sections/ new section can be dragged to the plan and by click “go to section” the cross section can be shown with the required level of detail, figure (4.5) shows cross section for stair with rebar.

*Drawings for multiple floors.*

Architectural drawings, which include floors, walls, windows, doors, and stairs, can also be extracted from Revit program easily by just selecting the required level and editing the visibility and graphics from properties to filter drawing’s categories, also from properties, the view range might need to be edited to view some required details. Figure (4.6), (4.7) and (4.8) shows the structural drawings for ground, first, second, and third floor respectively.

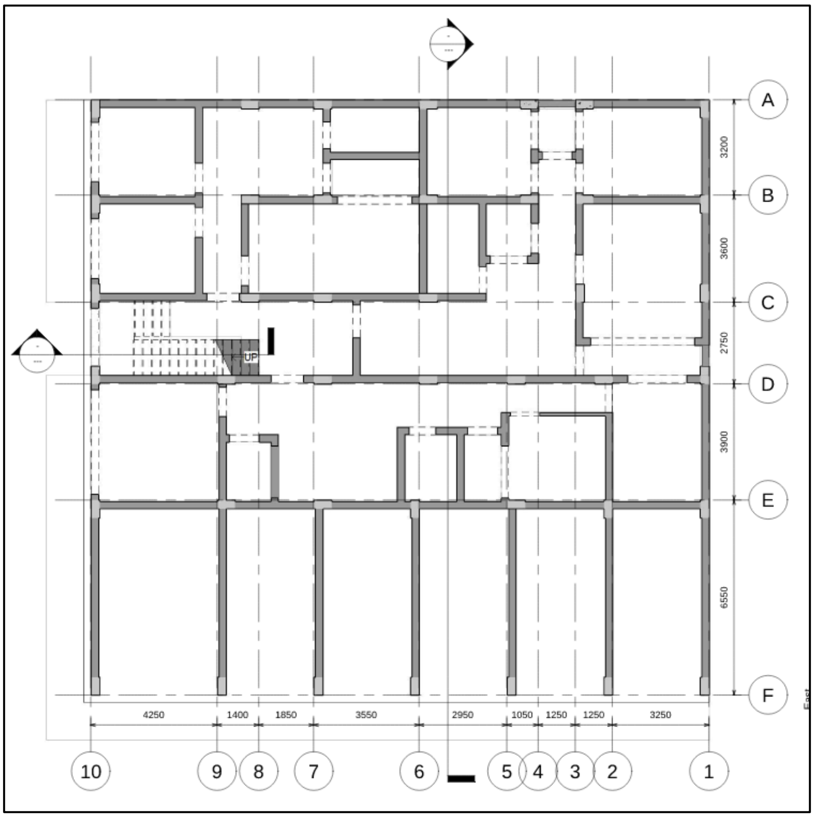



**Figure 4.6:** Level 0 (Ground Floor Plan)

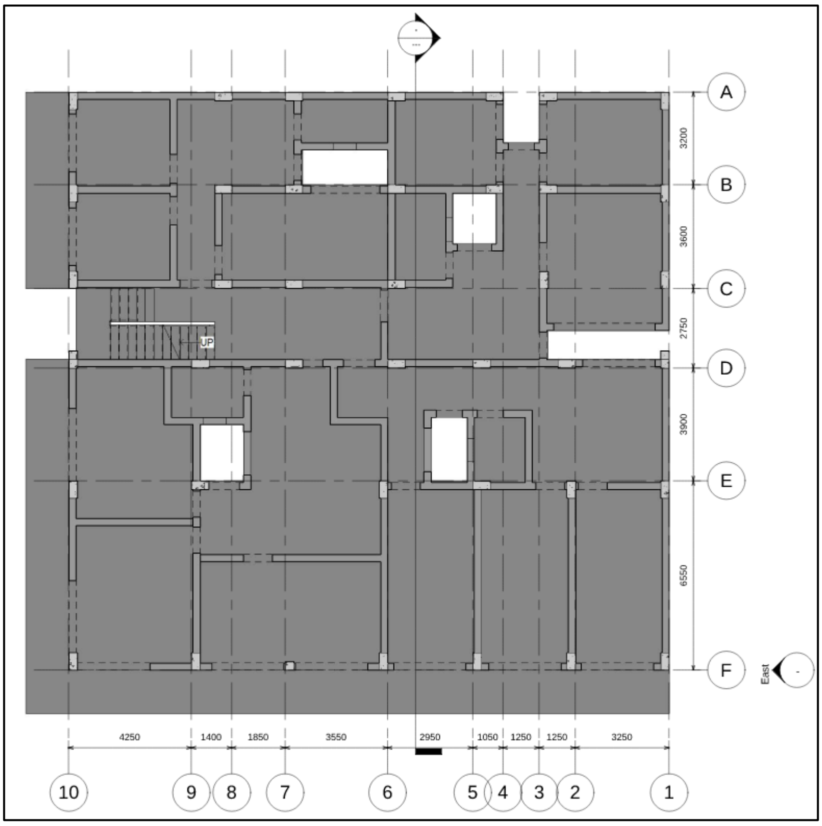



**Figure 4.7:** Level 1 (First Floor Plan)

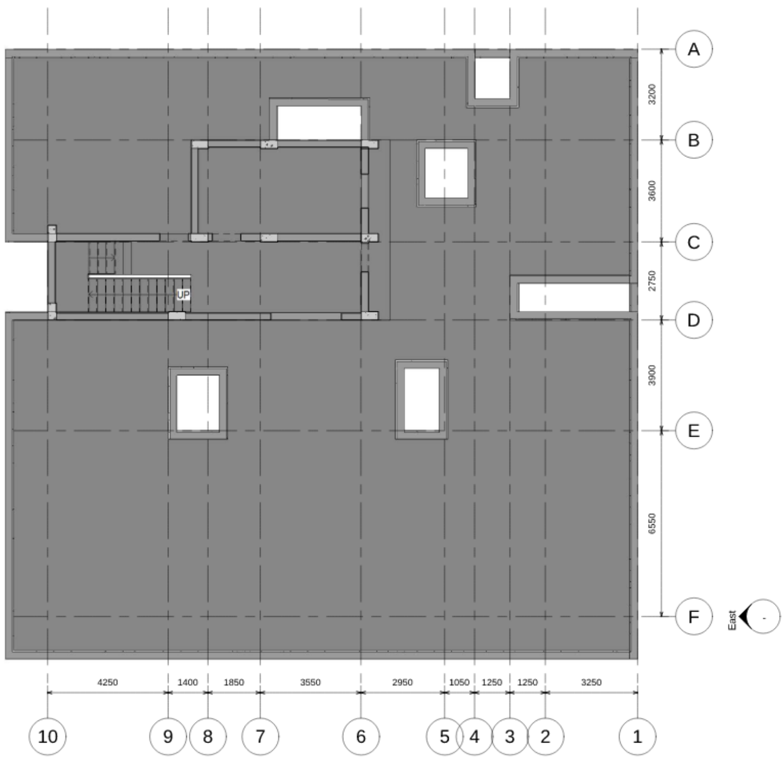



**Figure 4.8:** Level 3 (Third Floor Plan)

## 4.2 Preparing Bills of Quantities From Revit Program

Autodesk Revit as one of the programs that depends on BIM technology, when the building's parts were created, it didn't create it as merely shapes, everything created was actually set of information that helps the program to coordinate all the project, also those information can be invested to obtain BOQ with high level of details. in this section, exhibition of some schedules that have been made with Revit with a limited level of details as needed:

### Blinding and Raft Foundation concrete quantities

From view / schedules / schedule/quantities/Structural Foundations was selected and the fields added as volume, cost, perimeter, area, thickness, and comments. The only hand entered data was the unit price of 95000 and 110000 IQD of the volume for raft foundation and blinding respectively. Table (4.1) shows blinding and raft foundation's concrete quantities.

**Table 4.1:** Blinding and Raft Foundation's Concrete Quantities

| <Structural Foundation Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | Cost IQD | Perimeter | Area | Foundation Thickne | Comments |
| 255.76 | 28133300 | 82600 | 426 m$^2$ | 600 | raft foundation |
| 64.22 | 7064600 | 92600 | 535 m$^2$ | 120 | blinding |

### Raft Foundation's rebar quantities

From view / schedules / schedule/quantities/Structural Rebar was selected and the fields added as weight, cost, bar diameter, reinforcement volume, spacing, and comments. The only hand entered data was the unit price of 1300000 IQD per Ton for all bar diameters. Table (4.2) shows raft foundation's rebar schedule.

**Table 4.2:** Raft Foundation's Rebar Details & Quantities

| Raft Rebar Schedule | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | Cost IQD | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 2.762325 | 3591000 | 16 mm | 0.351889 m$^3$ | 249 mm | Raft Rebars |
| 2.762325 | 3591000 | 16 mm | 0.351889 m$^3$ | 249 mm | Raft Rebars |
| 2.76837 | 3598900 | 16 mm | 0.352659 m$^3$ | 249 mm | Raft Rebars |
| 2.76837 | 3598900 | 16 mm | 0.352659 m$^3$ | 249 mm | Raft Rebars |
| 11.06139 | 14379800 | | 1.409094 m$^3$ | | |

### Column concrete quantities

From view / schedules / schedule/quantities/ Structural Columns was selected and the fields added as volume, cost, type, count, base level, and top level. Cost formula was entered as volume multiplied by 95000. Table (4.3), (4.4), (4.5) and (4.6) show column schedule and concrete quantity schedules for ground, first, second, and third floor respectively.

**Table 4.3:** Ground Floor's Column Schedule & Concrete Quantity

| <Structural Column Schedule Ground Floor> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | Cost IQD | Type | Count | Base Level | Top Level |
| | | | | | |
| 26.57 m³ | 2524000 | 300 x 600 mm | 41 | Level 0 | Level 1 |

**Table 4.4:** First Floor's Column Schedule & Concrete Quantity

| <Structural Column Schedule 1st. Floor> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | Cost IQD | Type | Count | Base Level | Top Level |
| | | | | | |
| 0.23 | 22200 | 300 x 300mm | 1 | Level 1 | Level 2 |
| 17.78 | 1689500 | 300 x 600 mm | 38 | Level 1 | Level 2 |
| 18.02 | 1711700 | | | | |

**Table 4.5:** Second Floor's Column Schedule & Concrete Quantity

| <Structural Column Schedule 2nd. Floor> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | Cost IQD | Type | Count | Base Level | Top Level |
| | | | | | |
| 0.23 | 22200 | 300 x 300mm | 1 | Level 2 | Level 3 |
| 17.78 | 1689500 | 300 x 600 mm | 38 | Level 2 | Level 3 |
| 18.02 | 1711700 | | | | |

**Table 4.6:** Third Floor's Column Schedule & Concrete Quantity

| <Structural Column Schedule 3rd. Floor> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | Cost IQD | Type | Count | Base Level | Top Level |
| | | | | | |
| 4.39 m³ | 417200 | 300 x 600 mm | 10 | Level 3 | Level 4 |
| 4.39 m³ | 417200 | | | | |

**Column Rebar quantities.**

From view / schedules / schedule / quantities/Structural Rebar was selected and the fields added as weight, cost, bar diameter, reinforcement volume, spacing, and comments. Then the results were filtered by comments equal G.F col. Cost formula was entered as weight multiplied by 920000. Table (4.7), (4.8), (4.9) and (4.10) show column rebar quantity schedule for ground, first, second, and third floor respectively.

**Table 4.7:** Ground Floor's Column Rebar Schedule

<G.F column Rebar Schedule>

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| weghit | cost | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| | | | | | |
| 1.926187 | 1772100 | 10 mm | 0.245374 $m^3$ | 120 mm | G.F col. |
| 0.16469 | 151500 | 10 mm | 0.020980 $m^3$ | 248 mm | G.F col. |
| 4.529825 | 4167400 | 16 mm | 0.577048 $m^3$ | | G.F col. |
| 6.620701 | 6091000 | | 0.843401 $m^3$ | | |

**Table 4.8:** First Floor's Column Rebar Schedule

<1st.Floor column Rebar Schedule>

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| weghit | cost | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| | | | | | |
| 1.263008 | 1162000 | 10 mm | 0.160893 $m^3$ | 120 mm | 1st.&2nd.F col. |
| 0.076377 | 70300 | 10 mm | 0.009730 $m^3$ | 745 mm | 1st.&2nd.F col. |
| 3.409206 | 3136500 | 16 mm | 0.434294 $m^3$ | | 1st.&2nd.F col. |
| 4.748591 | 4368700 | | 0.604916 $m^3$ | | |

**Table 4.9:** Second Floor's Column Rebar Schedule

<Second Floor column Rebar Schedule>

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| weghit | cost | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| | | | | | |
| 1.263008 | 1162000 | 10 mm | 0.160893 $m^3$ | 120 mm | 2nd.col. |
| 0.020099 | 18500 | 10 mm | 0.002560 $m^3$ | 745 mm | 2nd.col. |
| 2.881095 | 2650600 | 16 mm | 0.367018 $m^3$ | | 2nd.col. |
| 4.164202 | 3831100 | | 0.530472 $m^3$ | | |

**Table 4.10:** Third Floor's Column Rebar Schedule

| <3rd. Floor column Rebar Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | cost | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 0.250561 | 230500 | 10 mm | 0.031919 m³ | 150 mm ... 150 mm | 3rd.col. |
| 0.640804 | 589500 | 16 mm | 0.081631 m³ | | 3rd.col. |
| 0.891365 | 820100 | | 0.113550 m³ | | |

### Slab's concrete and formwork quantities

From view / schedules / schedule / quantities/ Floors were selected and the fields added as volume, area, perimeter, elevation at top, default thickness, formwork area, cost (of concrete) and formwork cost. Formwork area was entered as a formula equals ((Area + perimeter) *default thickness), Cost of concrete was a formula of (volume*95000), and formwork cost was a formula of (formwork area*10000) Then the results were filtered by elevation at top. Table (4.11), (4.12), (4.13) and (4.14) show slab's concrete and formwork quantity schedule for ground, first, second, and third floor respectively.

**Table 4.11:** Ground Floor's Slab Concrete and Formwork Schedule

| <G.Floor Concrete & Formwork Schedule> | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H |
| Volume | Area | Perimeter | Elevation at Top | Default Thickness | Formwork Area | Cost IQD | formwork Cost IQD |
| 89.59 m³ | 448 m² | 131688 | 4200 | 200 | 474.3 | 8511100 | 4742900 |

**Table 4.12:** First Floor's Slab Concrete and Formwork Schedule

| <1st. Floor Concrete & Formwork Schedule> | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H |
| Volume | Area | Perimeter | Elevation at Top | Default Thickness | Formwork Area | Cost IQD | formwork Cost IQD |
| 89.59 m³ | 448 m² | 131688 | 7400 | 200 | 474.3 | 8511100 | 4742900 |

**Table 4.13:** Second Floor's Slab Concrete and Formwork Schedule

| <2nd. Floor Concrete & Formwork Schedule> | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H |
| Volume | Area | Perimeter | Elevation at Top | Default Thickness | Formwork Area | Cost IQD | formwork Cost IQD |
| 89.59 m³ | 448 m² | 131688 | 10600 | 200 | 474.3 | 8511100 | 4742900 |

**Table 4.14:** Third Floor's Slab Concrete and Formwork Schedule

<3rd. Floor Concrete & Formwork Schedule>

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| Volume | Area | Perimeter | Elevation at Top | Default Thickness | Formwork Area | Cost IQD | formwork Cost IQD |
| 11.97 m³ | 60 m² | 36800 | 13600 | 200 | 67.2 | 1137200 | 672100 |

**Beam's concrete quantities**

From view / schedules / schedule / quantities/ Structural Framing was selected and the fields added as volume, cost IQD, count, length, elevation at top, family and type, and formwork area. Formwork area was entered as a formula equals (beam formwork cross section * length), Then the results were filtered by elevation at top. Table (4.15), (4.16), (4.17) and (4.18) show concrete for beams and formwork schedule for ground, first, second, and third floor respectively.

**Table 4.15:** Ground Floor's Beams Concrete & Formwork Schedule

<G.F. Floor Structural Framing Concrete Schedule>

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| 29.24 m³ | 2777600 | 18 | 249000 | 4200 | M_Concrete-Rectangular Beam: 300 x 600m | 273.9 |
| 29.24 m³ | 2777600 | | 249000 | | | 273.9 |

**Table 4.16:** First Floor's Beams Concrete & Formwork Schedule

<1st. Floor Structural Framing Concrete Schedule>

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| 27.41 m³ | 2603800 | 17 | 232200 | 7400 | M_Concrete-Rectangular Beam: 300 x 600m | 255.42 |
| 27.41 m³ | 2603800 | | 232200 | | | 255.42 |

**Table 4.17:** Second Floor's Beams Concrete & Formwork Schedule

<2nd. Floor Structural Framing Concrete Schedule>

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| 22.09 m³ | 2098500 | 15 | 188100 | 10600 | M_Concrete-Rectangular Beam: 300 x 600m | 206.91 |
| 22.09 m³ | 2098500 | | 188100 | | | 206.91 |

**Table 4.18:** Third Floor's Beams Concrete & Formwork Schedule

| <3rd. Floor Structural Framing Concrete Schedule> | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| | | | | | | |
| 1.48 m³ | 140200 | 3 | 13050 | 13600 | M_Concrete-Rectangular Beam: 300 x 600m | 14.355 |
| 1.48 m³ | 140200 | | 13050 | | | 14.355 |

**Parapets concrete quantities**

From view / schedules / schedule / quantities/ Structural Framing was selected and the fields added as volume, cost IQD, count, length, elevation at top, family and type, and formwork area. Formwork area was entered as a formula equals (Parapet cross section * length), Then the results were filtered by elevation at top. Table (4.19), (4.20), (4.21) and (4.22) show parapets and formwork quantity schedule for ground, first, second, and third floor respectively.

**Table 4.19:** Ground Floor's Parapets Concrete & Formwork Schedule

| <G.F. Floor Structural Framing (parapets) Concrete Schedule> | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| | | | | | | |
| 1.85 m³ | 176100 | 7 | 46450 | 4400 | M_Concrete-Rectangular Beam: 200x200mm | 18.58 |
| 1.85 m³ | 176100 | | 46450 | | | 18.58 |

**Table 4.20:** First Floor's Parapets Concrete & Formwork Schedule

| <1st. Floor Structural Framing (parapets) Concrete Schedule> | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| | | | | | | |
| 1.85 m³ | 176100 | 7 | 46450 | 7600 | M_Concrete-Rectangular Beam: 200x200mm | 27.87 |
| 1.85 m³ | 176100 | | 46450 | | | 27.87 |

**Table 4.21:** Second Floor's Parapets Concrete & Formwork Schedule

| <2nd. Floor Structural Framing (parapets) Concrete Schedule> | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| | | | | | | |
| 5.21 m³ | 495000 | 30 | 85738 | 10800 | M_Concrete-Rectangular Beam: 200x300mm | 60.01651 |
| 7.89 m³ | 749800 | 2 | 43500 | 10800 | M_Concrete-Rectangular Beam: 300 x 800m | 82.65 |
| 13.10 m³ | 1244800 | | 129238 | | | 142.66651 |

**Table 4.22:** Third Floor's Parapets Concrete & Formwork Schedule

| <3rd. Floor Structural Framing (parapets) Concrete Schedule> | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Volume | Cost IQD | Count | Length | Elevation at Top | Family and Type | formwork area |
| 0.35 m³ | 32800 | 1 | 6350 | 13800 | M_Concrete-Rectangular Beam: 200x300mm | 1.905 |
| 5.36 m³ | 509600 | 5 | 29740 | 13800 | M_Concrete-Rectangular Beam: 300 x 800m | 44.61 |
| 5.71 m³ | 542400 | | 36090 | | | 46.515 |

### Stairs concrete quantities

From view / schedules / schedule / quantities/ Stairs was selected and the fields added as top level, volume, cost, actual number of rises, actual riser height, actual tread depth, formwork area, and formwork cost. Formwork cost was entered as a formula equal (formwork area * 10000). Then the results were sorted by top level. Table (4.23) shows stairs material takeoff schedule.

**Table 4.23:** Stairs Material Takeoff

| <Stairs Material Takeoff> | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H |
| Top Level | Material: Volume | Cost | Actual Number of | Actual Riser Height | Actual Tread Depth | formwork area | formwork cost |
| Level 1 | 3.07 m³ | 291800 | 20 | 210 | 300 | 15.01 | 150100 |
| Level 2 | 2.71 m³ | 257300 | 17 | 188 | 300 | 13.81 | 138100 |
| Level 3 | 2.71 m³ | 257300 | 17 | 188 | 300 | 13.81 | 138100 |

### Rebar quantities for slab, beams, and stairs

From view / schedules / schedule / quantities/Structural Rebar was selected and the fields added as weight, cost, bar diameter, reinforcement volume, spacing, and comments. Then the results were filtered by comments. Cost formula was entered as weight multiplied by 1300000. Table (4.24), (4.25), (4.26) and (4.27) show slab, beam, and stair's rebar quantity schedule for ground, first, second, and third floor respectively.

**Table 4.24:** Ground Floor's Slab, Beams & Stair Rebar Schedule

| <G.F slab, Beams &stair Rebar Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | Cost IQD | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 0.931564 | 1211000 | 10 mm | 0.118671 m³ | 250 mm | GF.slab&beams |
| 8.54332 | 11106300 | 12 mm | 1.088321 m³ | | GF.slab&beams |
| 2.487205 | 3233400 | 16 mm | 0.316841 m³ | | GF.slab&beams |
| 11.962088 | 15550700 | | 1.523833 m³ | | |

**Table 4.25:** First Floor's Slab, Beams & Stair Rebar Schedule

| <First Floor slab, Beams &stair Rebar Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | Cost IQD | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 0.899202 | 1169000 | 10 mm | 0.114548 m³ | 223 mm ... 268 mm | 1st. slab |
| 8.41709 | 10942200 | 12 mm | 1.072241 m³ | | 1st. slab |
| 2.149315 | 2794100 | 16 mm | 0.273798 m³ | | 1st. slab |
| 11.465607 | 14905300 | | 1.460587 m³ | | |

**Table 4.26:** Second Floor's Slab, Beams & Stair Rebar Schedule

| <Second Floor slab, Beams &stair Rebar Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | Cost IQD | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 0.930559 | 1209700 | 10 mm | 0.118543 m³ | 223 mm ... 268 mm | 2nd&beam. slab |
| 8.41709 | 10942200 | 12 mm | 1.072241 m³ | | 2nd&beam. slab |
| 2.147026 | 2791100 | 16 mm | 0.273507 m³ | | 2nd&beam. slab |
| 11.494675 | 14943100 | | 1.464290 m³ | | |

**Table 4.27:** Third Floor's Slab & Beams Rebar Schedule

| <3rd. Floor slab, Beams Rebar Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| weghit | Cost IQD | Bar Diameter | Reinforcement Vol | Spacing | Comments |
| 0.190917 | 248200 | 10 mm | 0.024321 m³ | 147 mm ... 250 mm | 3rd.slab |
| 1.197359 | 1556600 | 12 mm | 0.152530 m³ | | 3rd.slab |
| 0.535798 | 696500 | 16 mm | 0.068254 m³ | | 3rd.slab |
| 1.924074 | 2501300 | | 0.245105 m³ | | |

### DPC material takeoff

From view / schedules / schedule / quantities/ Structural framing was selected and the fields added as type, length, type comments, volume, and cut length. Then the results were filtered by type comments equal to DPC. Table (4.28) shows DPC quantity schedule.

**Table 4.28:** DPC Schedule

| <DPC Schedule> | | | | |
|---|---|---|---|---|
| A | B | C | D | E |
| Type | Length | Type Comments | Volume | Cut Length |
| 250x150mm | 215.845 | DPC | 7.31 | 212.024 |

**Brick walls material takeoff.**

From view / schedules / schedule / quantities / Walls were selected and the fields added as volume, cost, area, base constrain, top constrain, and family and type. The cost field was a formula equal (volume*165000). Then the results were filtered by base constrain, and sorted by top constrain and family and type. Table (4.29), (4.30), (4.31) and (4.32) show brick wall quantity schedule for ground, first, second, and third floor respectively.

**Table 4.29:** Ground Floor's Brick Wall Schedule

| <Ground Floor's Wall Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | cost | Area | Base Constraint | Top Constraint | Family and Type |
| 0.98 | 160900 | 4 m² | Level 0 | Unconnected | Basic Wall: Generic - 250 |
| 1.25 | 206700 | 10 m² | Level 0 | Up to level: Level 1 | Basic Wall: Generic - 120 |
| 160.22 | 26435600 | 645 m² | Level 0 | Up to level: Level 1 | Basic Wall: Generic - 250 |
| 162.44 | 26803200 | 659 m² | | | |

**Table 4.30:** First Floor's Brick Wall Schedule

| <First Floor's Wall Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | cost | Area | Base Constraint | Top Constraint | Family and Type |
| 120.44 | 19872000 | 482 m² | Level 1 | Up to level: Level 2 | Basic Wall: brick 250 mm |
| 120.44 | 19872000 | 482 m² | | | |

**Table 4.31:** Second Floor's Brick Wall Schedule

| <Second Floor's Wall Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | cost | Area | Base Constraint | Top Constraint | Family and Type |
| 120.44 | 19872000 | 482 m² | Level 2 | Up to level: Level 3 | Basic Wall: brick 250 mm |
| 120.44 | 19872000 | 482 m² | | | |

**Table 4.32:** Third Floor's Brick Wall Schedule

| <Third Floor's Wall Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Volume | cost | Area | Base Constraint | Top Constraint | Family and Type |
| | | | | | |
| 44.07 | 7270800 | 176 m² | Level 3 | Up to level: Level 4 | Basic Wall: brick 250 mm |
| 44.07 | 7270800 | 176 m² | | | |

### Roof Isolation material takeoff

From view / schedules / schedule / quantities / Rooms were selected and the fields added as area, name, upper limit, and isolation cost. The isolation cost field was a formula equal (area*27000). Then the results were filtered by name equals Roof tiles, and sorted also by name. Table (4.33) shows roof isolation quantity schedule.

**Table 4.33:** Roof Isolation Schedule

| <Roof isolation schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Area | Name | Upper Limit | Isolation cost |
| | | | |
| 49 | Roof tiles | Level 4 | 1330515 |
| 367 | Roof tiles | Level 3 | 9899796 |
| 416 | | | 11230311 |

### Plaster and facade marble material takeoff

From view / schedules / material takeoff / multi-category was selected and the fields added as Material: area, material: name, material: cost, total cost. The total cost field was a formula equal (Material: cost * Material: Area). Material: cost was already entered in the properties of each material when created. The results were filtered by comments equal plaster & facade, and sorted ascendingly by material: name. Table (4.34) shows Plaster and facade marble material takeoff schedule.

**Table 4.34:** Plaster and Facade Marble Schedule

| <Plaster & facade marble Material Takeoff> | | | |
|---|---|---|---|
| A | B | C | D |
| Material: Area | Material: Name | Material: Cost | Total cost |
| | | | |
| 306 | Marble facade | 75000 | 22957089 |
| 1135 | Plaster P | 11000 | 12480384 |

**Facade sweep material takeoff**

From view / schedules / material takeoff / multi-category was selected and the fields added as length, material: name, material: cost, total cost. The total cost field was a formula equal (Material: cost * length). Material: cost was already entered in the properties of each material when created. The results were filtered by material: name equal facade sweep, and sorted ascendingly by material: name. Table (4.35) shows facade sweep material takeoff schedule.

**Table 4.35:** Facade Sweep Schedule

| <Facade sweep Material Takeoff> | | | |
|---|---|---|---|
| A | B | C | D |
| length | Material: Name | Material: Cost | Total Cost |
| 356.8 | facade sweep | 35000 | 12489337 |

The other part of facade sweep is related to the windows that have facade view, so from windows schedule, the fields added as comments, perimeter, and cost. The cost field was a formula equal (perimeter * 35000). The results were filtered by comments equal facade window. Table (4.36) shows window facade sweep material takeoff schedule.

**Table 4.36:** Facade Window Sweep Schedule

| <Facade Window Sweep Schedule> | | |
|---|---|---|
| A | B | C |
| Comments | perimeter | cost |
| facade window | 234 | 8183000 |

**Gypsum plastering material takeoff**

From view / schedules / schedule / quantities / Walls was selected and the fields added as material: area, cost, material: name, and base constrain. The total cost field was a formula equal (Material: area * 16000). The results were filtered by material: name equal gypsum, and sorted ascendingly by base constrain. Table (4.37) shows wall gypsum plastering material takeoff schedule.

**Table 4.37:** Wall Gypsum Plastering Schedule

| <Wall Gypsum Plastering Material Takeoff> | | | | |
|---|---|---|---|---|
| A | B | C | D | E |
| Material: Area | Cost | Material: Name | Base Constraint | Material: Volume |
| 1029 | 16460219 | Gypsum | Level 0 | 19.55 m³ |
| 658 | 10527575 | Gypsum | Level 1 | 11.79 m³ |
| 658 | 10527587 | Gypsum | Level 2 | 11.79 m³ |
| 104 | 1656638 | Gypsum | Level 3 | 1.93 m³ |

The other part of gypsum is on related to the roof, so from view / schedules / schedule / quantities / Rooms were selected and the fields added as area, name, upper limit, and roof gypsum cost. The roof gypsum cost field was a formula equal (area*16000). Then the results were filtered by name does not equal court, balcony and roof tiles and sorted also by name. Table (4.38) shows roof gypsum plastering material takeoff schedule.

**Table 4.38:** Roof Gypsum Plastering Schedule

| <Roof gypsum plastering> | | | |
|---|---|---|---|
| A | B | C | D |
| Area | Name | Upper Limit | roof gypsum cost |
| 342 | | Level 0 | 5479775 |
| 324 | | Level 1 | 5191763 |
| 324 | | Level 2 | 5191844 |
| 43 | Bedroom | Level 3 | 691968 |

### Floor marble material takeoff

From view / schedules / schedule / quantities / Rooms were selected and the fields added as area, name, upper limit, and floor marble cost. The floor marble cost field was a formula equal (area*45000). Then the results were filtered by name does not equal bathroom, does not equal court, and upper limit equals level 0, and also sorted by name. Table (4.39) shows ground floor’s marble material takeoff schedule.

**Table 4.39:** Floor Marble Schedule

| <Floor Marble Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Area | Name | Upper Limit | Floor marble cost |
| | | | |
| 114 | Bedroom | Level 0 | 5152330 |
| 36 | corridor | Level 0 | 1603018 |
| 60 | kitchen | Level 0 | 2692502 |
| 119 | shop | Level 0 | 5360215 |
| 329 | | | 14808065 |

### Floor porcelain material takeoff

From view / schedules / schedule / quantities / Rooms were selected and the fields added as area, name, upper limit, and floor porcelain cost. The floor porcelain cost field was a formula equal (area*32000). Then the results were filtered by name does not equal bathroom, does not equal court, does not equal roof tiles, and upper limit does not equal level 0, and also sorted by name. Table (4.40) shows floor porcelain material takeoff schedule.

**Table 4.40:** Floor Porcelain Schedule

| <Floor Porcelain Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Area | Name | Upper Limit | Floor Porcelain cos |
| | | | |
| 95 | Balkony | | 3052747 |
| 494 | Bedroom | | 15794541 |
| 165 | kitchen | | 5273333 |
| 754 | | | 24120621 |

### Wall ceramic material takeoff

From view / schedules / schedule / quantities / Walls was selected and the fields added as material: comment, material: area, base constrain, material cost, and total cost. The total cost field was a formula equal (Material: cost * Material: area). Material: cost was already entered in the properties of each material when created. The results were filtered by material: comment equal ceramic, and sorted ascendingly by base constrain. Table (4.41) shows wall ceramic material takeoff schedule.

**Table 4.41:** Wall Ceramic Schedule

| <Ceramic Material Takeoff> | | | | |
|---|---|---|---|---|
| A | B | C | D | E |
| Material: Comment | Material: Area | Base Constraint | Material: Cost | Total Cost |
| Ceramic | 259 | Level 0 | 40000 | 10356122 |
| Ceramic | 265 | Level 1 | 40000 | 10608406 |
| Ceramic | 265 | Level 2 | 40000 | 10608406 |

**Paint material takeoff**

From view / schedules / schedule / quantities / Walls was selected and the fields added as material: area, cost, material: name, and base constrain. The cost field was a formula equal (Material: area * 6000). The results were filtered by material: name equal gypsum, and sorted ascendingly by base constrain. Table (4.42) shows wall paint material takeoff schedule.

**Table 4.42:** Wall Paint Schedule

| <Wall Paint Material Takeoff> | | | |
|---|---|---|---|
| A | B | C | D |
| Material: Area | Cost | Material: Name | Base Constraint |
| 1029 | 6172582 | Gypsum | Level 0 |
| 658 | 3947841 | Gypsum | Level 1 |
| 658 | 3947845 | Gypsum | Level 2 |
| 104 | 621239 | Gypsum | Level 3 |

The other part of gypsum is on related to the roof, so from view / schedules / schedule / quantities / Rooms were selected and the fields added as area, name, upper limit, and roof paint cost. The roof paint cost field was a formula equal (area*6000). Then the results were filtered by name does not equal court, balcony and roof tiles, and sorted also by name. Table (4.43) shows roof paint material takeoff schedule.

**Table 4.43:** Roof Paint Schedule

| <Roof Paint Material Takeoff> | | | |
|---|---|---|---|
| A | B | C | D |
| Area | Name | Upper Limit | Roof paint cost |
| 342 | | Level 0 | 2054916 |
| 324 | | Level 1 | 1946406 |
| 324 | | Level 2 | 1946406 |
| 43 | Bedroom | Level 3 | 259488 |

### Skirting material takeoff

From view / schedules / schedule / quantities / Rooms were selected and the fields added as perimeter, marble skirting cost, name, and upper limit. The marble skirting cost field was a formula equal (perimeter * 7500). Then the results were filtered by name does not equal bathroom, court, and kitchen, and upper limit equals level 0, and also sorted by name. Table (4.44) shows marble skirting material takeoff schedule.

**Table 4.44:** Marble Skirting Schedule

| <Marble Skirting Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Perimeter | marble skirting cost | Name | Upper Limit |
| 129 | 965322 | Bedroom | Level 0 |
| 114 | 852654 | shop | Level 0 |
| 242 | 1817976 | | |

The same procedure above is applied again to get porcelain skirting material takeoff, The marble skirting cost field was a formula equal (perimeter * 6000). Then the results were filtered by name does not equal bathroom, court, kitchen, roof tiles and balcony, and upper limit does not equal level 0, and also sorted by upper limit. Table (4.45) shows porcelain skirting material takeoff schedule.

**Table 4.45:** Porcelain Skirting Schedule

| <Porcelain Skirting Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Perimeter | Porcelain skirting c | Name | Upper Limit |
| 242 | 1451857 | Bedroom | Level 1 |
| 242 | 1452037 | Bedroom | Level 2 |
| 44 | 264240 | Bedroom | Level 3 |
| 528 | 3168133 | | |

### Door's schedule

From view / schedules / schedule / quantities / Doors were selected and the fields added as Family and type, width, count, and cost. Then the results were sorted ascendingly by width. Table (4.46) shows door's quantity schedule.

**Table 4.46:** Door's Schedule

| <Door Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Family and Type | Width | Count | Cost |
| M_Door-Opening: 900x 2200 m | 900 | 11 | 2200000 |
| M_Door-Opening: 1000x 2200 m | 1000 | 34 | 8500000 |
| M_Door-Opening: 1100x 2700m | 1100 | 11 | 12100000 |
| M_Door-Opening: 2000x 2700m | 2000 | 1 | 1300000 |

### Railing schedule

From view / schedules / schedule / quantities / Railing was selected and the fields added as Family and type, length, railing height, and cost. The cost field was a formula equal (length * 95000). Then the results were sorted ascendingly by family and type. Table (4.47) shows railing quantity schedule.

**Table 4.47:** Railing Schedule

| <Railing Schedule> | | | |
|---|---|---|---|
| A | B | C | D |
| Family and Type | Length | Railing Height | Cost |
| Railing: 900mm | 27 | 900 | 2604274 |
| Railing: 900mm fac | 92 | 900 | 8758050 |
| Grand total: 10 | 120 | | 11362324 |

### Windows schedule

From view / schedules / schedule / quantities / Doors were selected and the fields added as Family and type, width, height, count, area, and cost. The cost field was a formula equal (Area * 160000). Then the results were sorted ascendingly by family and type. Table (4.48) shows Aluminum windows quantity schedule.

**Table 4.48:** Aluminum Windows Schedule

| <Aluminum Window Schedule> | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | E | F |
| Family and Type | Width | Height | Count | Area | Cost |
| M_Window-Square Opening: 800 x 600 mm | 800 | 600 | 11 | 5 | 844800 |
| M_Window-Square Opening: 0900 x 1200mm | 900 | 1200 | 6 | 6 | 1036800 |
| M_Window-Square Opening: 0900 x 1800mm | 900 | 1800 | 2 | 3 | 518400 |
| M_Window-Square Opening: 1200x 1800mm | 1200 | 1800 | 8 | 17 | 2764800 |
| M_Window-Square Opening: 1500x 1600mm | 1500 | 1600 | 4 | 10 | 1536000 |
| M_Window-Square Opening: 1600x 1800mm | 1200 | 1800 | 1 | 2 | 345600 |
| M_Window-Square Opening: 2000x 2200 mm | 2000 | 2200 | 1 | 4 | 704000 |
| M_Window-Square Opening: 2000x 2500 mm | 2000 | 2500 | 2 | 10 | 1600000 |
| M_Window-Square Opening: 2400x 1800mm | 2400 | 1800 | 2 | 9 | 1382400 |
| M_Window-Square Opening: 2500x 1800mm | 2500 | 1800 | 1 | 5 | 720000 |
| M_Window-Square Opening: 2500x 2400 mm | 2500 | 2400 | 18 | 108 | 17280000 |
| M_Window-Square Opening: 3500x 1800mm | 3500 | 1800 | 2 | 13 | 2016000 |
| M_Window-Square Opening: W1 2x2 | 2000 | 1400 | 7 | 20 | 3136000 |
| M_Window-Square Opening: W2 2.5x2 | 2500 | 1400 | 1 | 4 | 560000 |
| M_Window-Square Opening: W3 1.25x2 | 1250 | 1400 | 3 | 5 | 840000 |
| M_Window-Square Opening: W4 3.5x2 | 3500 | 1400 | 2 | 10 | 1568000 |
| M_Window-Square Opening: W5 kitchen 1.75 | 1750 | 1400 | 1 | 2 | 392000 |
| M_Window-Square Opening: W6 1.75x2 | 1750 | 1400 | 1 | 2 | 392000 |
| M_Window-Square Opening: Window door10 | 1000 | 2100 | 6 | 13 | 2016000 |
| Grand total: 79 | | | | 248 | 39652800 |

From view / schedules / schedule / quantities / windows were selected and the fields added as Family and type, area, and protection cost. The protection cost field was a formula equal (Area * 50000). Then the results were sorted ascendingly by family and type. Table (4.49) shows windows protection quantity schedule.

**Table 4.49:** Windows Protection Schedule

| <Windows Protection Schedule> | | |
|---|---|---|
| A | B | C |
| Family and Type | Area | protection cost |
| M_Window-Square Opening: W1 2x2 | 8.4 | 420000 |
| M_Window-Square Opening: W2 2.5x2 | 3.5 | 175000 |
| M_Window-Square Opening: W3 1.25x2 | 5.25 | 262500 |
| M_Window-Square Opening: W4 3.5x2 | 9.8 | 490000 |
| M_Window-Square Opening: W5 kitchen 1.75x2 | 2.45 | 122500 |
| M_Window-Square Opening: W6 1.75x2 | 2.45 | 122500 |
| M_Window-Square Opening: Window door1000x2100 | 6.3 | 315000 |
| Grand total: 14 | 38.15 | 1907500 |

## 4.3 Comparison Schedules

After the data was listed, it was collected in two brief schedules, to compare the quantities and prices obtained by Revit software, with the data of the tender BOQ, the first table was for comparing the material and cost for the main structure of the building, while the second table was for the finishing quantities and pricing comparison.

**Table 4.50:** Material and Cost Comparison (For Main Structure)

| No. | Description | Unit | Revit Quantity | Tender Quantity | Difference | Revit price | Tender price | Difference |
|---|---|---|---|---|---|---|---|---|
| 1 | Excavation 0.6m from the surface | m3 | 417 | 417 | 0.000 | 3753000 | 3753000 | 0 |
| 2 | filling with subbase and compacting | m3 | 278 | 278 | 0.000 | 4865000 | 4865000 | 0 |
| 3 | Blinding 12cm | m3 | 64.22 | 67 | -2.780 | 7064200 | 7370000 | -305800 |
| 4 | Sanitaries | - | - | - | | 2000000 | 2000000 | 0 |
| 5 | Raft foundation's rebar, | Ton | 11.06 | 12 | -0.939 | 14379807 | 15600000 | -1220193 |
| 6 | raft foundation's formwork | - | - | - | | 1500000 | 1500000 | 0 |
| 7 | raft foundation concrete 60 cm | m3 | 255.76 | 275 | -19.240 | 24297200 | 26125000 | -1827800 |
| 8 | Ground floor's column concrete | m3 | 26.57 | 30 | -3.430 | 2524150 | 2850000 | -325850 |
| 9 | Ground floor's column formwork & Rebar works | Count | 41 | 41 | 0.000 | 6150000 | 6150000 | 0 |
| 10 | rebar for G.F columns 10mm and 16mm | Ton | 6.62 | 7 | -0.379 | 6091045 | 6440000 | -348955 |
| 11 | concrete for slab and beams of G.F | m3 | 123.75 | 133 | -9.250 | 11756250 | 12635000 | -878750 |
| 12 | rebar for G.F slab-beams and stair 10mm, 12mm and 16mm | Ton | 11.96 | 12 | -0.038 | 15550714 | 15600000 | -49286 |
| 13 | G.F formwork for slab-beam and stairs | m2 | 781.79 | 690 | 91.790 | 7817900 | 6900000 | 917900 |
| 14 | rebar for 1st. Floor columns 10mm and 16mm | Ton | 4.75 | 5.00 | -0.251 | 4482124 | 4600000 | -117876 |
| 15 | First floor's column formwork & Rebar works | Count | 39 | 39.00 | 0.000 | 5850000 | 5850000 | 0 |
| 16 | First floor's column concrete | m3 | 18.02 | 21.00 | -2.980 | 1756550 | 1995000 | -238450 |
| 17 | 1st. floor formwork for slab-beam and stairs | m2 | 762.11 | 690 | 72.110 | 7621100 | 6900000 | 721100 |

**Table 4.50:** (Cont.) Material and Cost Comparison (For Main Structure)

| No. | Description | Unit | Revit Quantity | Tender Quantity | Difference | Revit price | Tender price | Difference |
|---|---|---|---|---|---|---|---|---|
| 18 | rebar for 1st. slab-beams and stair 10mm, 12mm and 16mm | Ton | 11.47 | 12.00 | -0.534 | 14905289 | 15600000 | -694711 |
| 19 | concrete for slab and beams of 1st. Floor | m3 | 121.56 | 133 | -11.440 | 11548200 | 12635000 | -1086800 |
| 20 | rebar for 2nd. Floor columns 10mm and 16mm | Ton | 4.16 | 5.00 | -0.836 | 3944486 | 4600000 | -655514 |
| 21 | second floor's column formwork & Rebar works | Count | 39 | 39.00 | 0.000 | 5850000 | 5850000 | 0 |
| 22 | Second floor's column concrete | m3 | 18.02 | 21.00 | -2.980 | 1756550 | 1995000 | -238450 |
| 23 | 2nd. floor formwork for slab-beam and stairs | m2 | 798.92 | 710 | 88.915 | 7989151 | 7100000 | 889151 |
| 24 | rebar for 2nd. floor slab-beams and stair 10mm, 12mm and 16mm | Ton | 11.49 | 12.50 | -1.005 | 14943078 | 16250000 | -1306923 |
| 25 | concrete for slab and beams of 2nd. Floor | m3 | 127.49 | 136 | -8.510 | 12111550 | 12920000 | -808450 |
| 26 | rebar for 3rd. Floor columns 10mm and 16mm | Ton | 0.89 | 1.20 | -0.309 | 820056 | 1104000 | -283944 |
| 27 | Third floor's column formwork & Rebar works | Count | 10 | 10.00 | 0.000 | 1500000 | 1500000 | 0 |
| 28 | Third floor's column concrete | m3 | 4.39 | 5.00 | -0.610 | 417050 | 475000 | -57950 |
| 29 | 3rd. floor formwork for slab & beam | m2 | 128.07 | 95.00 | 33.070 | 1280700 | 950000 | 330700 |
| 30 | rebar for 3rd. floor slab & beams, 10mm, 12mm and 16mm | Ton | 1.92 | 2.00 | -0.076 | 2501296 | 2600000 | -98704 |
| 31 | concrete for slab and beams of 3rd. Floor | m3 | 19.16 | 17.00 | 2.160 | 1820200 | 1615000 | 205200 |
| 32 | DPC | M | 215.85 | 170 | 45.845 | 1942605 | 1530000 | 412605 |
| 33 | Ground floor's Brick wall works | M3 | 162.44 | 155 | 7.440 | 26802600 | 25575000 | 1227600 |
| 34 | First floor's Brick wall works | M3 | 120.44 | 108 | 12.440 | 19872600 | 17820000 | 2052600 |
| 35 | Second floor's Brick wall works | M3 | 120.44 | 108 | 12.440 | 19872600 | 17820000 | 2052600 |
| 36 | Third floor's Brick wall works | M3 | 44.07 | 48.00 | -3.930 | 7271550 | 7920000 | -648450 |
| | **SUM** | | | | | | | -2699539 |

**Table 4.51:** Material and Cost Comparison (For Finishing)

| No. | Description | Unit | Revit quantity | Tender quantity | Difference | Revit price | Tender price | Difference |
|---|---|---|---|---|---|---|---|---|
| 1 | Roof tiles & isolation | M2 | 416 | 420 | -4 | 11230311 | 11340000 | -109689 |
| 2 | G.F. gypsum plastering | M2 | 1371 | 1355 | 16 | 21939994 | 21680000 | 259994 |
| 3 | 1st.F. gypsum plastering | M2 | 982 | 1240 | -258 | 15719338 | 19840000 | -4120662 |
| 4 | 2nd.F. gypsum plastering | M2 | 982 | 1240 | -258 | 15719431 | 19840000 | -4120569 |
| 5 | 3rd.F. Gypsum plastering | M2 | 147 | 160 | -13 | 2348606 | 2560000 | -211394 |
| 6 | plastering | M2 | 1135 | 1290 | -155 | 12480384 | 14190000 | -1709616 |
| 7 | Facade marble tiles | M2 | 306 | 325 | -19 | 22957089 | 24375000 | -1417911 |
| 8 | Facade marble sweeps | M | 590.8 | 650 | -59.2 | 20672337 | 22750000 | -2077663 |
| 9 | G.F. ceramic | M2 | 259 | 260 | -1 | 10356122 | 10400000 | -43878 |
| 10 | 1st.F. ceramic | M2 | 265 | 315 | -50 | 10608406 | 12600000 | -1991594 |
| 11 | 2nd.F. ceramic | M2 | 265 | 315 | -50 | 10608406 | 12600000 | -1991594 |
| 12 | G.F paint | M2 | 1371 | 1355 | 16 | 8227498 | 8130000 | 97498 |
| 13 | 1st.F paint | M2 | 982 | 1240 | -258 | 5894247 | 7440000 | -1545753 |
| 14 | 2nd.F paint | M2 | 982 | 1240 | -258 | 5894251 | 7440000 | -1545749 |
| 15 | 3rd.F paint | M2 | 147 | 160 | -13 | 880727 | 960000 | -79273 |
| 16 | G.F marble | M2 | 329 | 325 | 4 | 14808065 | 14625000 | 183065 |
| 17 | porcelain other floors | M2 | 754 | 820 | -66 | 24120621 | 26240000 | -2119379 |
| 18 | Bathrooms & court's tiles | no. | 17 | 17 | 0 | 3400000 | 3400000 | 0 |
| 19 | stair steps | no. | 54 | 51 | 3 | 4050000 | 3825000 | 225000 |
| 20 | G.F skirting | M | 242 | 260 | -18 | 1817976 | 1950000 | -132024 |
| 21 | Other floor's skirting | M | 528 | 600 | -72 | 3168894 | 3600000 | -431106 |
| 22 | Steel Main door | no. | 1 | 1 | 0 | 1300000 | 1300000 | 0 |
| 23 | main doors for flats | no. | 11 | 11 | 0 | 12100000 | 12100000 | 0 |
| 24 | 1m width | no. | 34 | 34 | 0 | 8500000 | 8500000 | 0 |
| 25 | 90cm width | no. | 11 | 11 | 0 | 2200000 | 2200000 | 0 |
| 26 | Aluminum windows | M2 | 248 | 260 | -12 | 39652800 | 41600000 | -1947200 |
| 27 | windows protection | M2 | 38.15 | 42 | -3.85 | 1907500 | 2100000 | -192500 |
| 28 | Aluminum Railing | M | 120 | 117 | 3 | 11362324 | 11115000 | 247324 |

**Table 4.51:** (Cont.) Material and Cost Comparison (For Finishing)

| No. | Description | Unit | Revit quantity | Tender quantity | Difference | Revit price | Tender price | Difference |
|---|---|---|---|---|---|---|---|---|
| 29 | Electricity works | no. | 670 | 670 | 0 | 33500000 | 33500000 | 0 |
| 30 | Sanitary works | | | | | 16000000 | 16000000 | 0 |
| 31 | Closet | no. | 11 | 11 | 0 | 1980000 | 1980000 | 0 |
| 32 | washbasin | no. | 11 | 11 | 0 | 2420000 | 2420000 | 0 |
| 33 | shower cabin | no. | 11 | 11 | 0 | 3850000 | 3850000 | 0 |
| 34 | Security man& house keeping | | | | | 6500000 | 6500000 | 0 |
| 35 | Finishing total price | | | | | 368175327 | 392950000 | -24774673 |

**Table 4.52:** Total Price Differences

| | Structure | Finishing | Total |
|---|---|---|---|
| Revit Price | 284292461 | 368175327 | 652467788 |
| Tender Price | 286992000 | 392950000 | 679942000 |
| Difference | -2699539 | -24774673 | -27474212 |

### 4.3 Discussion of the Results

By looking to figure (4.9), the differences between Revit and tender quantities for concrete material takeoff are clarified, starting by blinding, foundation, ground floor columns, ground floor slab & beams, first floor columns, first floor slab & beams, second floor columns, second floor slab & beams, and second floor columns, the quantities in Revit are evidentially less than the quantities of tender. But third floor slab & beams quantity in Revit is higher than the quantity of tender.

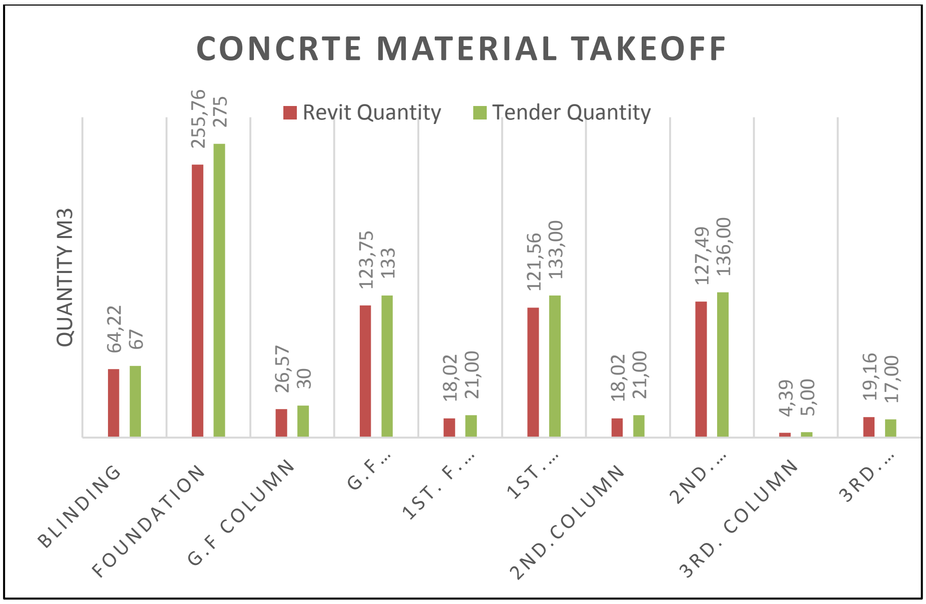



**Figure 4.9:** Concrete Material Takeoff

Figure (4.10), shows the differences between Revit and tender quantities for steel rebar material takeoff. Revit – based rebar quantities for foundation, ground floor column, first floor column, first floor slab, second floor column, second floor slab, third floor column, and third floor slab, are less than tender – based quantities, only ground floor slab quantity remains nearly the same with Revit and tender – based quantities. Generally, rebar quantities are estimated in higher than the Revit estimation values.

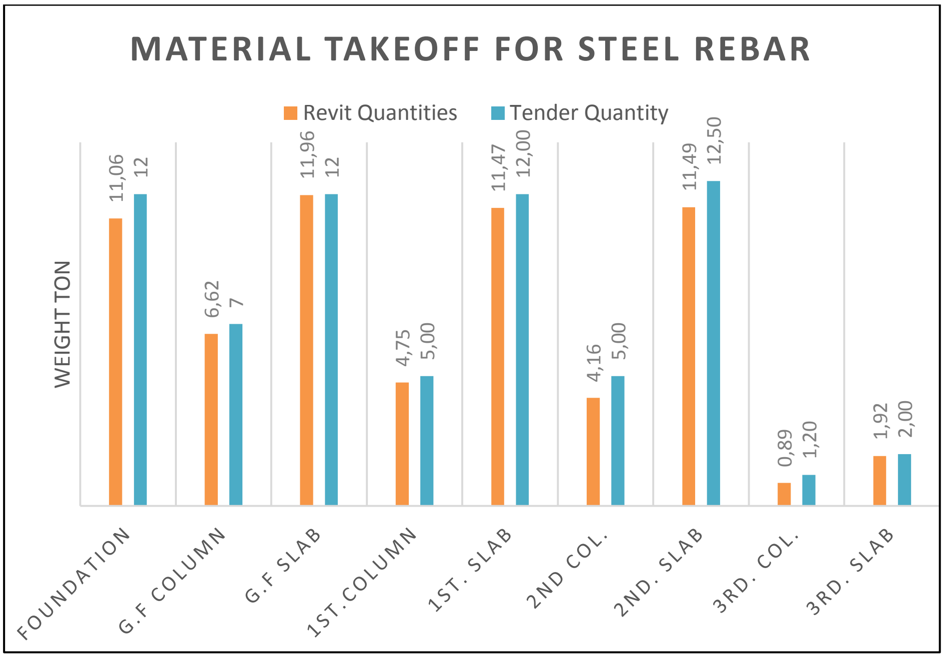



**Figure 4.10:** Rebar Material Takeoff

Formwork area, which is shown in figure (4.11), are also showing differences, but this time Revit – based values are greater than tender – based values and the difference is very sharp in all floors, this big gap might be occurs because of the lack of drawings and details, as each floor in addition to the floor formwork area has different longitudinal and lateral beams distribution and parapets, so the formwork area also differs in each floor.


**Figure 4.11:** Formwork Area

Figure (4.12) shows brick wall material takeoff for the 4 levels of the building, it shows big differences between Revit and tender – based quantities, ground floor's quantities were 162.44 $m^3$ and 155 $m^3$ for Revit and tender – based quantities respectively, first and second floor's quantities are the same which are 120.44 $m^3$ and 108 $m^3$ for Revit and tender based quantities respectively, while in third floor's quantities Revit quantity is 44.07 $m^3$ which is less than tender quantity that equals 48 $m^3$.

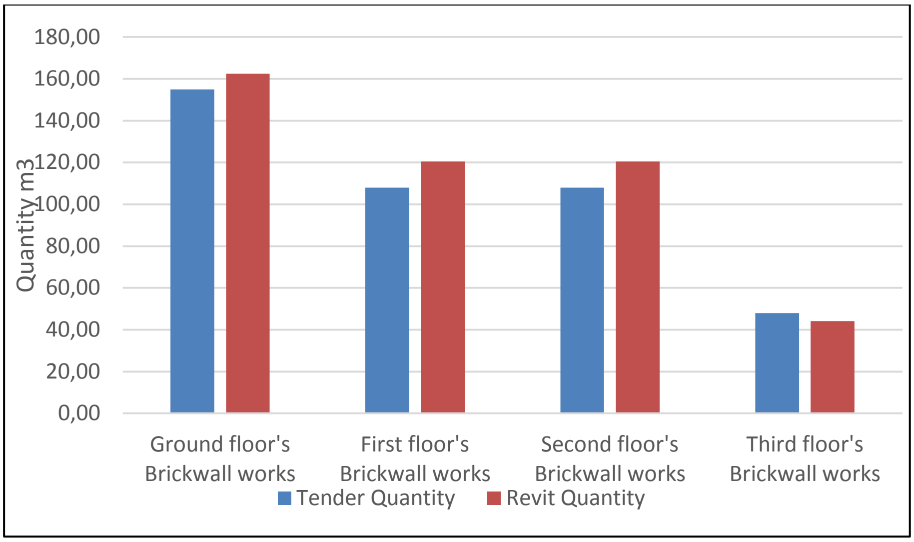



**Figure 4.12:** Brick Wall Material Takeoff

Figure (4.13) shows plastering material takeoff for the whole building and gypsum plastering material takeoff for each single floor in the building, ground floor's gypsum plastering quantities are 1371 $m^2$ and 1355 $m^2$ in Revit and tender – based estimation respectively, which can be considered the same quantity, while in first and second floor, the difference is extremely high, in Revit estimation, the value was 982 $m^2$ and for tender estimation the value was 1240 $m^2$, which is 21% more than Revit – based estimation. In third floor, the quantity was 147 $m^2$ and 160 $m^2$ in Revit and tender – based estimation respectively. Plastering estimation values were also different, with 1135 $m^2$ and 1290 $m^2$ in Revit and tender based estimation respectively.

It is noticeable that tender – based estimation quantities of brick wall in figure (4.) are less than Revit – based estimation quantities in ground, first and second floor, the normal altitude for tender – based gypsum plastering for the mentioned floors should also be less than Revit – based estimation, but by comparing figure (4.) and figure (4.) the contrast is very clear and that reflects the weakness of the traditional methods of estimation.

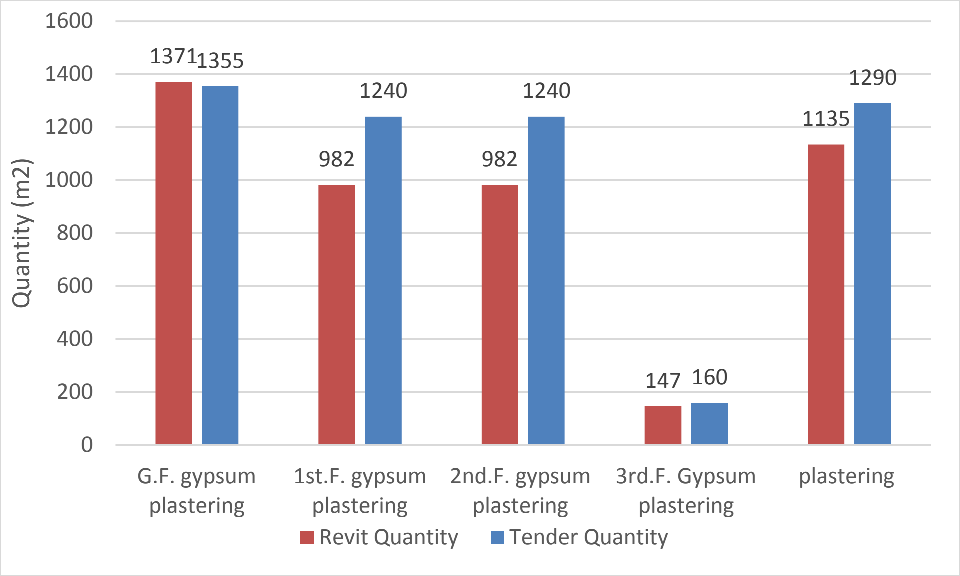



**Figure 4.13:** Plastering and Gypsum Plastering Material Takeoff

Figure (4.14) shows Facade marble tiles, ground floor's marble, floor porcelain, aluminum windows, and windows protection, Revit – based facade marble tiles estimated quantity is less than tender – based estimated quantity with 306 $m^2$ and 325 $m^2$. Ground floor's marble Revit -based estimated quantity was 329 and tender – based estimated quantity was 325 $m^2$ which can be considered the same. Floor porcelain Revit – based estimated quantity has a big difference from tender – based estimated quantity, it has a value of 754 $m^2$ comparing to 820 $m^2$ in Tender. Aluminum windows estimation values were also different, with 248 $m^2$ and 260 $m^2$ in Revit and tender based estimation respectively. Windows protection quantities in Revit – based estimation and tender – based estimation values are 38.15 $m^2$ and 42 $m^2$ respectively.

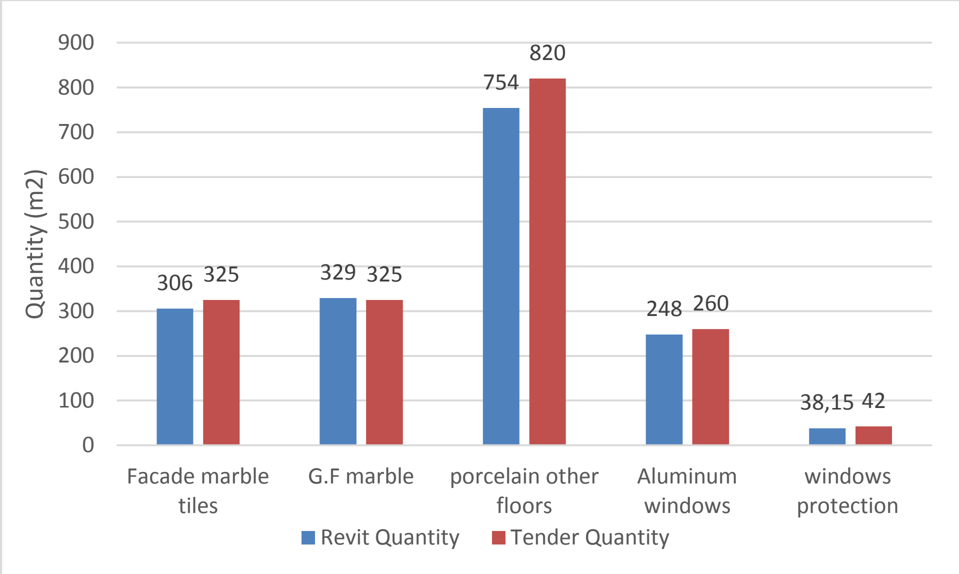



**Figure 4.14:** Marble, Porcelain and Aluminum Windows Material Takeoff

Figure (4.15) shows Facade marble sweeps, skirting, and aluminum railing. For facade marble sweeps, Revit – based estimated quantity is less than tender – based estimated quantity with 590.8 m and 650 m respectively. Ground floor's skirting and other floor's skirting Revit -based estimated quantity was 242, 528 m respectively, and tender – based estimated quantity was 260, 600 m respectively. Aluminum railing has nearly the same values for Revit and tender – based estimations which are 120 and 117 m respectively.

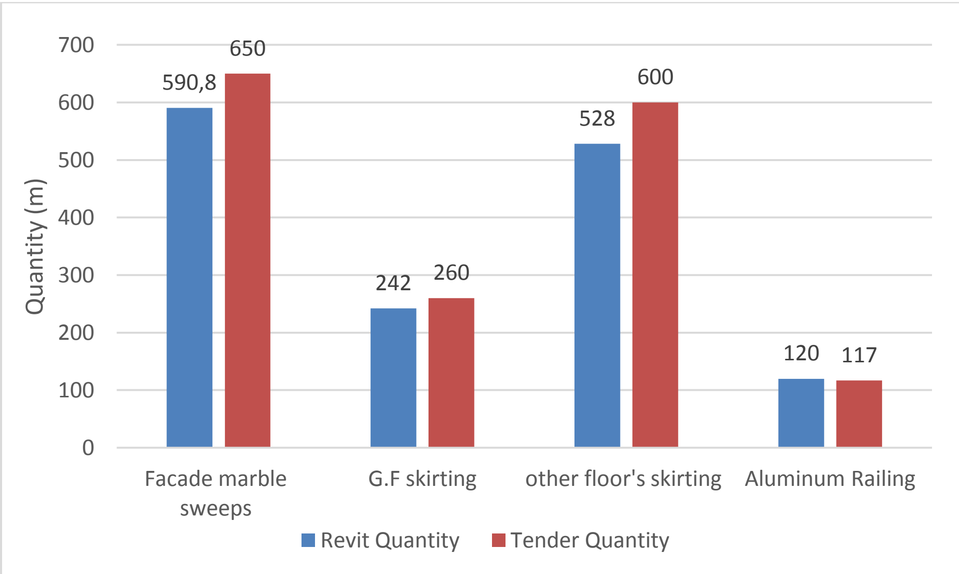



**Figure 4.15:** Facade Marble Sweep, Skirting and Aluminum Railing Material Takeoff

Finally, figure (4.16) shows ceramic material takeoff variances, ground floor's Revit – based estimated quantity nearly the same with tender – based estimated quantity. First and second floor's skirting and other floor's skirting Revit -based estimated quantity was 242, 528 m respectively, and tender – based estimated quantity was 260, 600 m respectively. Aluminum railing has nearly the same values for Revit and tender – based estimations which are 120 and 117 m respectively.

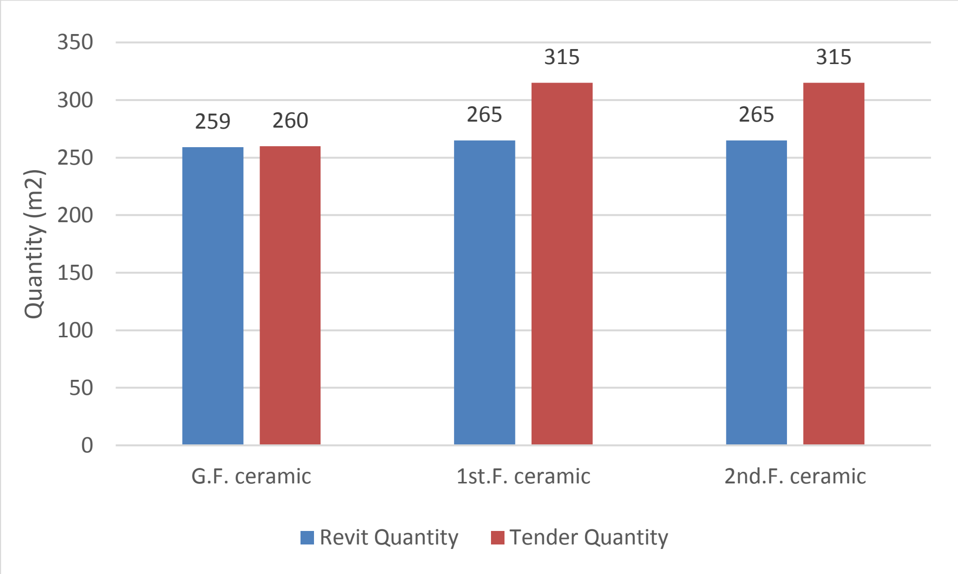



**Figure 4.16:** Ceramic Material Takeoff

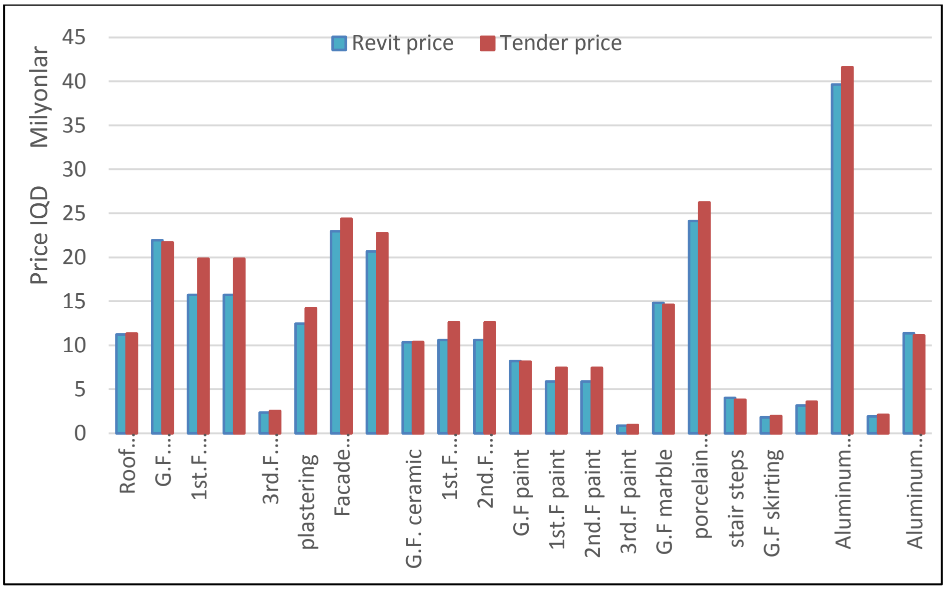



**Figure 4.17:** Price of Categories Revit vs. Tender (For Finishing)

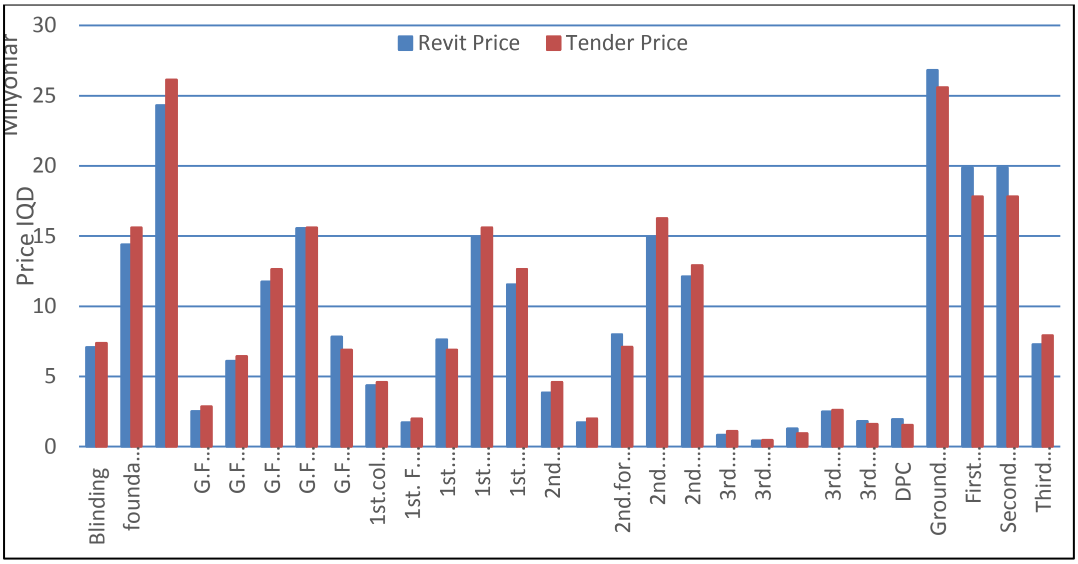



**Figure 4.18:** Price of Categories Revit vs. Tender (For Main Structure)

Difference in quantity naturally leads to difference in price, and the amount of variance in price depends on the estimated quantity and the unit price of each category, figure (4.17) and (4.18) show Revit and tender – based price of categories. It is obvious that some categories have a little increase or decrease in price due to either the little change in the quantity or the unit price of the category is not high. In other categories the difference in price is very sharp because of the big difference in Revit and tender – based quantities, also the unit price of the category itself is relatively high. When the estimated quantity is less than the actual quantity, the contractor will spend more than the predestined budget and that leads to reducing the expected profit, when the difference is too much, the contractor could lose and that might cause the project to stop.

However, the oscillation in categories prices causes the total price of the project to be different also, figure (4.19) indicates the total price of the structure, total price of finishing and total price of the building for both Revit and tender – based estimations.

The total price of structure was 284.29 million IQD for Revit – based estimation and 287 million IQD for tender – based estimation, the difference was not big, the reason behind that is because Revit – based formwork, DPC, 3$^{rd}$ floor slab & beams concrete and brick wall estimated quantities are more than tender – based estimated quantities, while in other categories Revit – based quantities are less, this have made a kind of equilibrium and the total price of the structure appears close.

For finishing price, Revit – based estimated cost was 368.17 million IQD, and tender – based estimated cost was 392.95 million IQD, Revit calculation have reduced the estimated cost by more than 6% compared to the tender estimated cost.

The total Revit – based estimated cost was 652.46 million IQD, and tender – based estimated cost was 679.94 million IQD, Revit calculation have reduced the total estimated cost by 4% compared to the tender estimated cost.

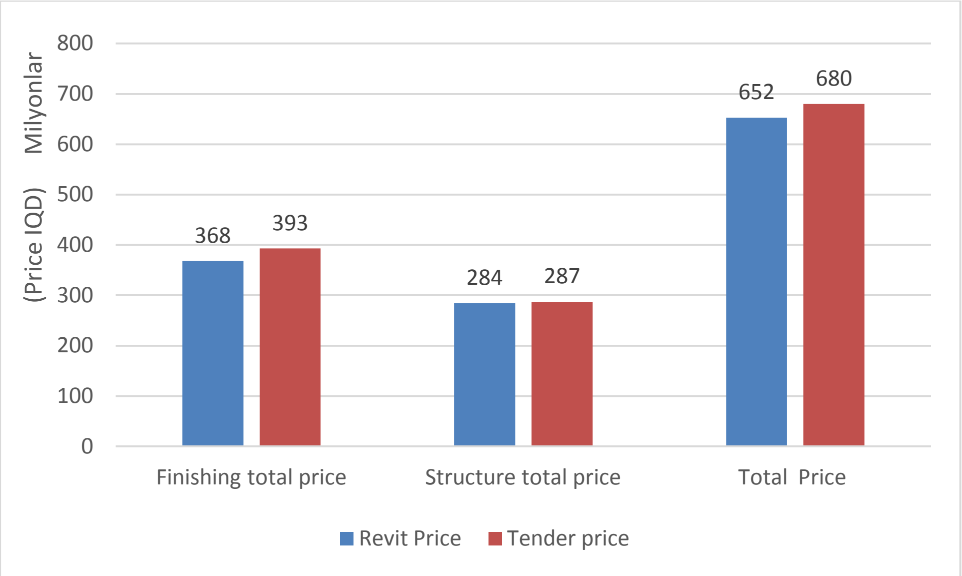



**Figure 4.19:** Estimated Total Price Revit Vs. Tender

# 5. CONCLUSIONS AND RECOMMENDATIONS

The main aim of this research is to evaluate the impact of implementation BIM technology on small scale projects, also, it aims to redirect the attention and increase the awareness of companies and stakeholders who deals with small projects.

In this research, a case study of 3-storey building was applied by one of BIM software (Autodesk Revit 2020), 2-D and 3-D drawings was extracted depending on the data used to create the model, some of these drawings was not available with the drawings that was made with Autodesk AutoCAD software. These drawings contain structural and architectural drawings, side views, and sections, without wasting time for drawing each one by hand.

Quantities estimations were obtained from the results of Revit software and compared with the quantities of the tender that were prepared with traditional methods, also the cost of each category was obtained and compared, the results can be abbreviated as the following:

- 37 categories of 70 showed that Revit – based quantities are less than tender quantities, while 12 categories showed that showed that Revit – based quantities are more than tender – based quantities, 3 categories showed nearly the same quantities, the rest 18 categories are fixed and with no quantity estimation.
- Concrete Revit – based quantities were less than tender – based quantities by with big difference for 9 of 10 of concrete categories.
- Revit – based rebar quantities was less than tender – based quantities for all rebar categories, but the difference was not too big.
- Revit – based quantities for all categories of formwork and 3 of 4 categories of brick wall were more than tender – based quantities with big differences.
- For finishes, Revit – based quantities for plastering, facade marble tiles, facade marble sweep, floor porcelain, aluminum windows, window's

protection, marble skirting, porcelain skirting, and 3 categories of ceramic quantities were less than tender – based quantities.

- The biggest gap was in the quantity of gypsum plastering and paint for 2 of 4 categories each, Revit based – quantities were extremely less than tender – based quantity.
- The results showed that the total Revit – based estimated cost was 652.46 million IQD, and tender – based estimated cost was 679.94 million IQD, Revit calculation have reduced the total estimated cost by 4% compared to the total tender estimated cost.
- Also, for finishing price, Revit – based estimated cost was 368.17 million IQD, and tender – based estimated cost was 392.95 million IQD, Revit calculation have reduced the estimated cost by more than 6% compared to the tender estimated cost for finishing.
- The total price of structure was 284.29 million IQD for Revit – based estimation and 287 million IQD for tender – based estimation, without a big difference in the total estimated price for the structure. However, prices for every category are more or less for both estimations, and that have made a kind of equilibrium.
- Determining the most correct material and cost estimation for the project helps contractors and owners to know their budget and reduces the gap between estimated and actual quantities during construction phase.
- The oscillation in quantities, in addition to it effect prices for each category, it could also lead to increase the time of the project.
- The other benefits of BIM which was mentioned in the literature review, included 3 – D rendering, shop drawings generating, building’s maintenance, material and cost estimation, interference detection, analytical analyses, reducing time of project delivery, team work friendly, and improving the quality of managing the project.
- Finally, the researcher concludes that BIM technology implementation for small scale construction projects is highly recommended to minimize interferences and saving time, and also the accurate cost estimation, also the

level of awareness to implement this technology by stakeholders should be raised.

**Future studies:**

- For the future studies the researcher suggest the following:
- Evaluate the feasibility of implementation of bim on small scale construction projects.
- Solving the barriers of using bim for the small companies and making a well organized and full considered formwork for training the design engineers.
- Deeper research on linking architectural, structural, and mep on a workset to minimize interferences and saving time.

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**APPENDICES**

**Appendix A: CAD Drawings**

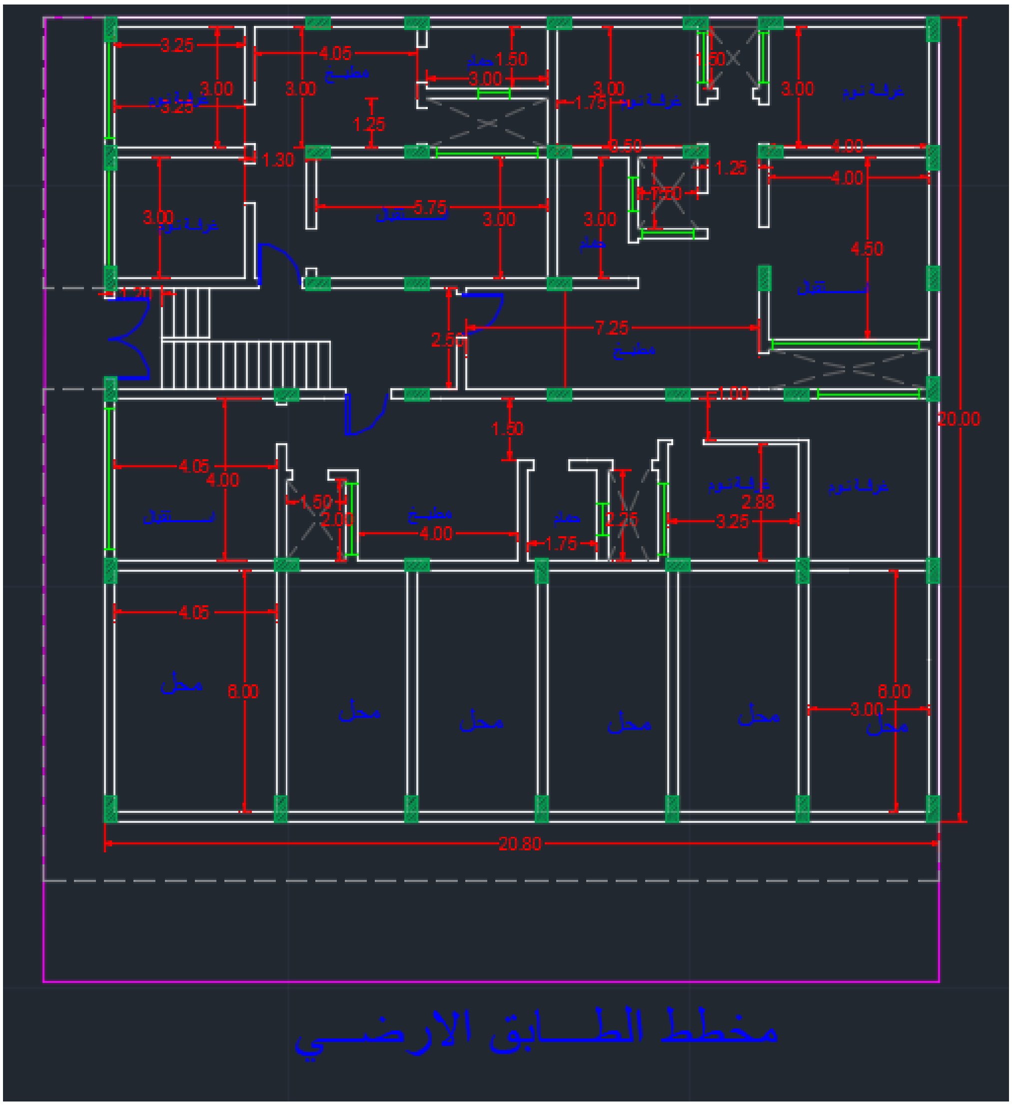


**Figure A.1:** Ground Floor’s CAD Drawing

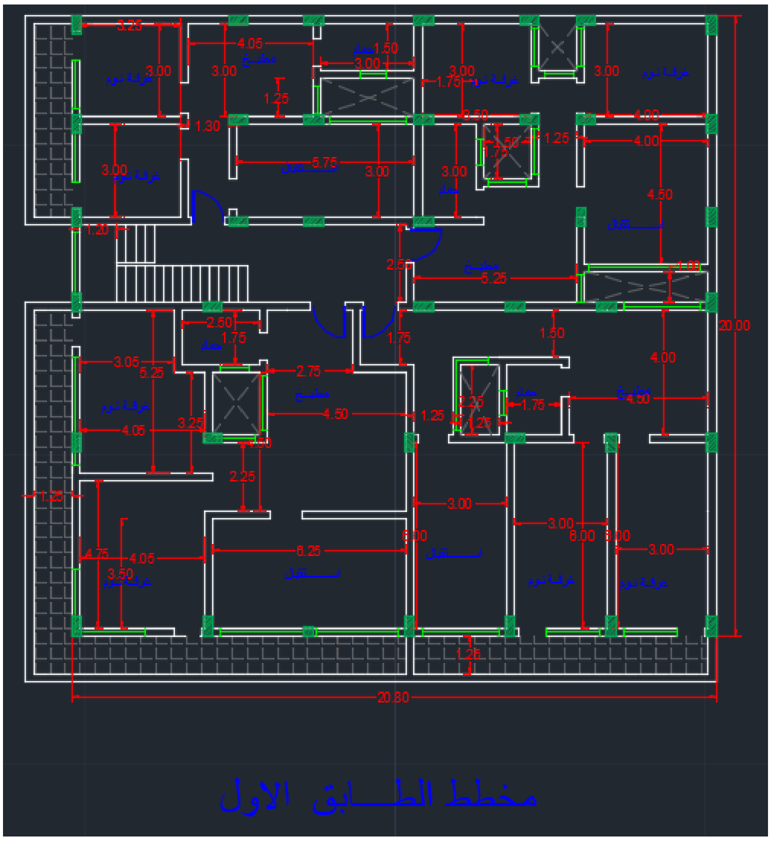


**Figure A.2:** First Floor's CAD Drawing

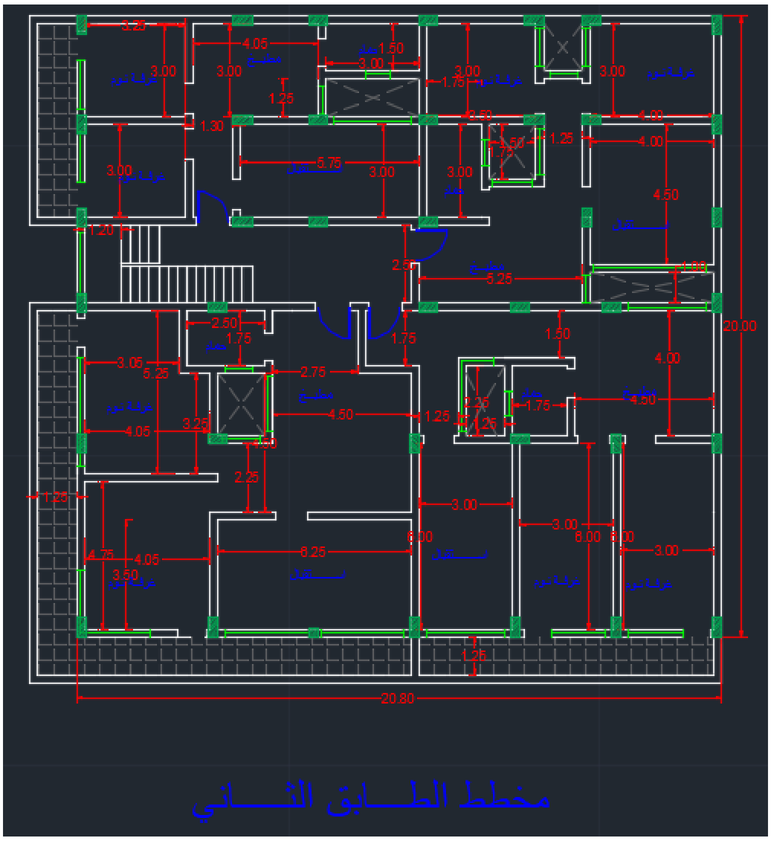


**Figure A.3:** Second Floor's CAD Drawing

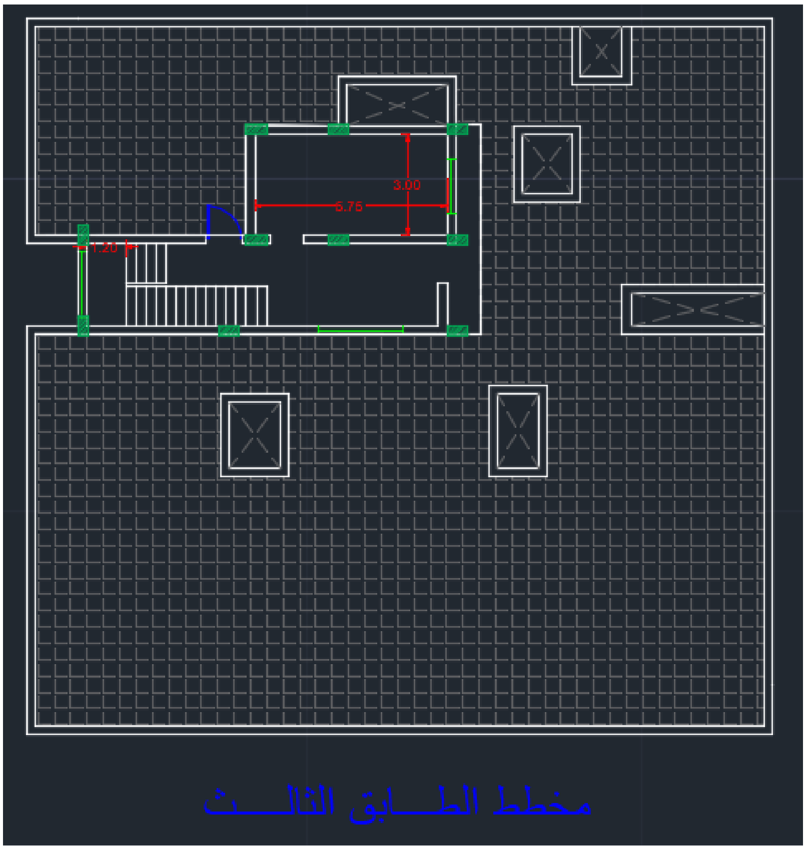


**Figure A.4:** Third Floor’s CAD Drawing

## Appendix B: Bills of Quantities (Tender)

**Table B.1:** Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم - اشراف – تنفيذ | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير - الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيــان الاعمال** | **ت** |
| **3753000** | **9,000** | 417 | $M^3$ | تجهيز العدد والاليات المناسبة لحفر الارض وحتى الوصول الى التربة الصالحة للتأسيس لتحقيق المقاومة التصميمية بعق لا يقل عن 0.6م من مستوى سطح الأرض ويشمل العمل نزح المياه إن وجدت وتنظيف الحفرة ورشها والحفاظ على جوانب الحفر طبقا للرسومات والمواصفات وتعليمات المهندس المشرف. | 1 |
| **4865000** | **17500** | 278 | $M^3$ | دفن الارض باستخدام السبيس الخابط المتدرج وعلى شكل طبقات لاتزيد من 15 - 25 سم مع الرش والحدل جيداً حتى الحصول على تربة متماسكة بنسبة حدل 95%، والقيام بجميع ما يلزم لإنهاء العمل بحسب الرسومات والمواصفات وتعليمات المهندس المشرف. | 2 |
| **7370000** | **110000** | 67 | $M^3$ | تجهيز وتنفيذ كونكريت بسماكة 12سم لقطعة الارض كاملة بإستخدام الأسمنت البورتلاندي مقاوم للاملاح وبمقاومة لا تقل عن 15 ميكا باسكال. السعر يشمل أعمال النجارة والرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **2000000** | **جملة** | جملة | جملة | تجهيز المواد اللازمة لتاسيس انابيب صحيات نوع الامل الشريف بقطر 4"،6" مع عمل منهولات وجميع ما يلزم العمل . | **2.1** |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | | شركة الخالد للمقاولات والبناء |
| موقع المشروع: بغداد | | | | | تصميم ـ اشراف ـ تنفيذ |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيـان الاعمال** | **ت** |
| **15600000** | **1300000** | 12 | طن | تجهيز حديد تسليح اوكراني المنشأ بقطر 16مم ثم القيام باعمال الحدادة بنشر طبقتين علوية وسفلية وباتجاهين ويكون النشر كل 25سم للطبقتين. | |
| **1500000** | **جملة** | جملة | | تجهيز المواد الازمة والعدد لاعمال القالب الخشبي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **26125000** | **95000** | 275 | $M^3$ | تجهيز وتنفيذ كونكريت بسماكة 60سم للاساس بإستخدام الأسمنت البورتلاندي مقاوم للاملاح وبمقاومة لا تقل عن 35ميكا باسكال .السعر يشمل أعمال الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | **1.2.1** |
| **2850000** | **95000** | 30 | $M^3$ | تجهيز وتنفيذ كونكريت لاعمدة الطابق الارضي بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **6150000** | **150000** | 41 | عدد | القيام باعمال الحدادة لاعمدة الطابق الارضي (14شيش قطر 16 ملم للحديد الرئيسي وقطر 10 ملم بمسافات 15ملم للاترية) وتجهيز المواد الازمة والعدد لاعمال القالب الخشبي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم ـ اشراف ــ تنفيذ | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيــان الاعمال** | **ت** |
| **6440000** | **920000** | 7.00 | طن | تجهيز حديد تسليح اوكراني المنشأ لاعمدة الطابق الارضي بقطر 16مم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا. | **2.2.1** |
| **12635000.00** | **95000** | 133.00 | M3 | تجهيز وتنفيذ كونكريت لسقف وجسور الطابق الارضي بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال , يكون سمك السقف 20سم والجسور (30*60) سم .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **15600000** | **1300000** | 12.00 | طن | جهيز حديد تسليح اوكراني المنشأ لسقف وجسور الطابق الارضي بقطر 16مم ,12ملم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا ثم القيام باعمال الحدادة للسقف بنشر طبقتين 12ملم بمسافات 20 سم بكلا الاتجاهين, و للجسور (7شيش قطر 16 ملم واترية 10ملم بمسافات 30 سم. | **3.2.1** |
| **6900000** | **10000** | 690.00 | m2 | تجهيز المواد الازمة والعدد لاعمال القالب الخشبي لسقف وجسور الطابق الارضي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **4600000** | **920000** | 5.00 | طن | تجهيز حديد تسليح اوكراني المنشأ لاعمدة الطابق الاول بقطر 16مم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم ـ اشراف ـ تنفيذ | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير - الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيـان الاعمال** | **ت** |
| **5850000** | **150000** | 39.00 | عدد | القيام باعمال الحدادة لاعمدة الطابق الاول (14شيش قطر 16 ملم للحديد الرئيسي وقطر 10 ملم بمسافات 15ملم للاترية) وتجهيز المواد الازمة والعدد لاعمال القالب الخشبي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **1995000** | **95000** | 21.00 | m3 | تجهيز وتنفيذ كونكريت لاعمدة الطابق الاول بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **6900000** | **10000** | 690.00 | m2 | تجهيز المواد الازمة والعدد لاعمال القالب الخشبي لسقف وجسور الطابق الاول باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **15600000** | **1300000** | 12.00 | طن | جهيز حديد تسليح اوكراني المنشأ لسقف وجسور الطابق الاول بقطر 16مم ,12ملم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا ثم القيام باعمال الحدادة للسقف بنشر طبقتين 12ملم بمسافات 20 سم بكلا الاتجاهين, و للجسور (7شيش قطر 16 ملم واترية 10ملم بمسافات 30 سم. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | | شركة الخالد للمقاولات والبناء |
| موقع المشروع: بغداد | | | | | تصميم ـ اشراف ـ تنفيذ |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيــان الاعمال** | **ت** |
| **12635000** | **95000** | 133.00 | m3 | تجهيز وتنفيذ كونكريت لسقف وجسور الطابق الاول بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال , يكون سمك السقف 20سم والجسور (30*60) سم .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **4600000** | **920000** | 5.00 | طن | تجهيز حديد تسليح اوكراني المنشأ لاعمدة الطابق الثاني بقطر 16مم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا. | |
| **5850000** | **150000** | 39.00 | عدد | القيام باعمال الحدادة لاعمدة الطابق الثاني (14شيش قطر 16 ملم للحديد الرئيسي وقطر 10 ملم بمسافات 15ملم للاترية) وتجهيز المواد الازمة والعدد لاعمال القالب الخشبي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **1995000** | **95000** | 21.00 | m3 | تجهيز وتنفيذ كونكريت لاعمدة الطابق الثاني بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم - اشراف – تنفيذ | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير - الهيكل | | | | | |
| الإجمالي | سعر الوحدة | الكميه | الوحدة | بيـان الاعمال | ت |
| 7100000 | 10000 | 710.00 | m2 | تجهيز المواد الازمة والعدد لاعمال القالب الخشبي لسقف وجسور الطابق الثاني باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| 16250000 | 1300000 | 12.50 | طن | جهيز حديد تسليح اوكراني المنشأ لسقف وجسور الطابق الثاني بقطر 16مم ,12ملم 10, ملم مطابق للمواصفات الهندسية ومفحوص مختبريا ثم القيام باعمال الحدادة للسقف بنشر طبقتين 12ملم بمسافات 20 سم بكلا الاتجاهين, و للجسور (7شيش قطر 16 ملم واترية 10ملم بمسافات 30 سم. | |
| 12920000 | 95000 | 136.00 | m3 | تجهيز وتنفيذ كونكريت لسقف وجسور الطابق الثاني بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال , يكون سمك السقف 20سم والجسور (30*60) سم .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| 1104000 | 920000 | 1.20 | طن | تجهيز حديد تسليح اوكراني المنشأ لاعمدة الطابق الثالث بقطر 16مم ,10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم ـ اشراف – تنفيذ | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيـان الاعمال** | **ت** |
| **1500000** | **150000** | 10.00 | عدد | القيام باعمال الحدادة لاعمدة الطابق الثالث (14شيش قطر 16 ملم للحديد الرئيسي وقطر 10 ملم بمسافات 15ملم للاترية) وتجهيز المواد الازمة والعدد لاعمال القالب الخشبي باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **475000** | **95000** | 5.00 | m3 | تجهيز وتنفيذ كونكريت لاعمدة الطابق الثالث بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **950000** | **10000** | 95.00 | m2 | تجهيز المواد الازمة والعدد لاعمال القالب الخشبي لسقف وجسور الطابق الثالث باستخدام خشب بلايود روسي وجميع ما يلزم لانهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **2600000** | **1300000** | 2.00 | طن | جهيز حديد تسليح اوكراني المنشأ لسقف وجسور الطابق الثالث بقطر 16مم ,12ملم, 10 ملم مطابق للمواصفات الهندسية ومفحوص مختبريا ثم القيام باعمال الحدادة للسقف بنشر طبقتين 12ملم بمسافات 20 سم بكلا الاتجاهين, و للجسور (7شيش قطر 16 ملم واترية 10ملم بمسافات 30 سم. | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | | شركة الخالد للمقاولات والبناء |
| موقع المشروع: بغداد | | | | | تصميم ـ اشراف ـ تنفيذ |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| الإجمالي | سعر الوحدة | الكميه | الوحدة | بيـان الاعمال | ت |
| **1615000** | **95000** | 17.00 | m3 | تجهيز وتنفيذ كونكريت لسقف وجسور الطابق الثالث بإستخدام الأسمنت البورتلاندي الاعتيادي وبمقاومة لا تقل عن 35ميكا باسكال , يكون سمك السقف 20سم والجسور (30*60) سم .السعر يشمل الرش بالماء وجميع ما يلزم لإنهاء العمل طبقاً للرسومات والمواصفات وتعليمات المهندس المشرف. | |
| **1530000** | **9000** | 170.00 | M | تسقيط موقع الجدران والقيام بأعمال القالب الخشبي لساف مانع الرطوبة (البادلو) بسمك 15سم ثم القيام بالصب باستخدام الكونكريت بنسبة 1:2:4 المخلوط بمادة السيكا المانعة للرطوبة (غير نفاذة). | |
| **25575000** | **165000** | 155.00 | m3 | و تجهيز المواد والعدد اللازمة لأعمال البناء للطابق الارضي بالطابوق جمهوري اصفر من النوع الجيد ومونة السمنت والرمل بنسبة خلط (1-3) وحسب الخارطة المتفق عليها والمرفقة مع جدول الكميات | |
| **17820000** | **165000** | 108.00 | m3 | و تجهيز المواد والعدد اللازمة لأعمال البناء للطابق الاول بالطابوق جمهوري اصفر من النوع الجيد ومونة السمنت والرمل بنسبة خلط (1-3) وحسب الخارطة المتفق عليها والمرفقة مع جدول الكميات | |

**Table B.1:** (Cont.) Tender and Bills of Quantities (Main Structure)

| | | | | | |
|---|---|---|---|---|---|
| شركة الخالد للمقاولات والبناء | | | رقم المشروع: N95 | | |
| تصميم ـ اشراف ـ تنفيذ | | | موقع المشروع: بغداد | | |
| | | | | | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الهيكل | | | | | |
| **ت** | **بيـــان الاعمال** | **الوحدة** | **الكميه** | **سعر الوحدة** | **الإجمالي** |
| | و تجهيز المواد والعدد اللازمة لأعمال البناء للطابق الثاني بالطابوق جمهوري اصفر من النوع الجيد ومونة السمنت والرمل بنسبة خلط (1-3) وحسب الخارطة المتفق عليها والمرفقة مع جدول الكميات | m3 | 108.00 | **165000** | **17820000** |
| | و تجهيز المواد والعدد اللازمة لأعمال البناء للطابق الثالث وستارة السطح (بارتفاع 1م) بالطابوق جمهوري اصفر من النوع الجيد ومونة السمنت والرمل بنسبة خلط (1-3) وحسب الخارطة المتفق عليها والمرفقة مع جدول الكميات | m3 | 48.00 | **165000** | **7920000** |
| | **المجموع :** | | | | **286992000** |

**Table B.2:** Tender and Bills of Quantities (Finishing)

| ت | بيـــان الاعمال | الوحدة | الكميه | سعر الوحدة | الإجمالي |
|---|---|---|---|---|---|
| | شركة الخالد للمقاولات والبناء | | | رقم المشروع: **N95** | |
| | **تصميم - اشراف – تنفيذ** | | | **موقع المشروع: بغداد** | |
| | **جداول كميات مشروع عمارة السيد سالم خضير - الانهاءات** | | | | |
| 1 | تجهيز المواد والقيام باعمال التسطيح باستعمال الشتايكر باستخدام فلانكوت وفوم سمك 5 سم مع ملئ المفاصل باستخدام الماستك وجميع ما يتطلبه العمل | M2 | 420 | 27000 | 11340000 |
| **2** | أعمال البياض بالجص المحلي عمل مساطر وزن ثم البياض بالجص سمك 2سم والانهاء بطبقة من البورك | | | | |
| **1.3** | **الطابق الارضي** | **M2** | **1355.0** | **16000** | **21680000** |
| **1.1.3** | الطابق الاول | M2 | 1240 | **16000** | **19840000** |
| | الثاني | M2 | 1240 | **16000** | **19840000** |
| | الثالث | M2 | 160 | **16000** | **2560000** |
| | **اللبخ الصقيل** | **M2** | | | |
| **3.1.3** | المناور وستائر السطح وخارج البيتونة لبخ ونثر | M2 | 1290 | **11000** | **14190000** |
| | **الواجهة (مرمر ابيض+ كوبلنات)** | | | | |
| | متر مربع مرمر | M2 | 325 | **75000** | **24375000** |
| | متر طول كوبلنات | M | 650 | **35000** | **22750000** |
| | **السيراميك الجداري: سيراميك هندي, لبخ + مادة لاصقة** | | | | |
| | ارضي | M2 | 260 | **40000** | **10400000** |
| | اول | M2 | 315 | **40000** | **12600000** |

**Table B.2:** (Cont.) Tender and Bills of Quantities (Finishing)

| | | | | | |
|---|---|---|---|---|---|
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم ـ اشراف – تنفيذ | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الانهاءات | | | | | |
| **الإجمالي** | **سعر الوحدة** | **الكميه** | **الوحدة** | **بيـــان الاعمال** | **ت** |
| **12600000** | **40000** | 315 | M2 | ثاني | |
| | | | | **الصبغ الداخلي** | |
| **8130000** | **6000** | 1355 | M2 | ارضي | |
| **7440000** | **6000** | 1240 | M2 | اول | |
| **7440000** | **6000** | 1240 | M2 | ثاني | |
| **960000** | **6000** | 160 | M2 | ثالث | |
| | | | | **الارضيات كرستة وعمل** | |
| **14625000** | **45000** | 325 | M2 | الارضي مرمر | |
| **26240000** | **32000** | 820 | M2 | باقي الطوابق بورسلين | |
| **3400000** | **200000** | 17 | عدد | ارضيات الحمامات والمناور | |
| **3825000** | **75000** | 51 | عدد | البايات مرمر | |
| | | | | | |
| | | | | **ازارة** | |
| **1950000** | **7500** | 260 | M | ارضي | |
| **3600000** | **6000** | 600 | M | باقي الطوابق | |
| **1300000** | **1300000** | 1 | عدد | **باب حديد مدخل رئيسي** | |
| **12100000** | **1100000** | 11 | عدد | **ابواب رئيسية مداخل الشقق** | |
| | | | | **ابواب داخلية** | |
| **8500000** | **250000** | 34 | عدد | عرض 1 متر للغرف | |

**Table B.2:** (Cont.) Tender and Bills of Quantities (Finishing)

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| رقم المشروع: N95 | | | | شركة الخالد للمقاولات والبناء | |
| موقع المشروع: بغداد | | | | تصميم ـ اشراف ـ تنفيذ | |
| جداول كميات مشروع عمارة السيد سالم خضير ـ الانهاءات | | | | | |
| الإجمالي | سعر الوحدة | الكميه | الوحدة | بيـــان الاعمال | ت |
| 2200000 | 200000 | 11 | عدد | عرض 90 حمامات | |
| 41600000 | 160000 | 260 | M2 | شبابيك المنيوم | |
| 2100000 | 50000 | 42 | M2 | كتائب شبابيك | |
| 11115000 | 95000 | 117 | M | محجر المنيوم | |
| 33500000 | 50000 | 670 | عدد | الكهربائيات | |
| 16000000 | | | قطعي | الصحيات | |
| | | | | تراكيب صحيات | |
| 1980000 | 180000 | 11 | عدد | مقعد غربي | |
| 2420000 | 220000 | 11 | عدد | مغسلة | |
| 3850000 | 350000 | 11 | عدد | شاور | |
| 6500000 | | | قطعي | اجور حراسة+عمال تنظيف | |
| 392950000 | المجموع : | | | | |

## RESUME

## EDUCATION:

- **Bachelor : ** 2017, University of Mustansiriyah, Faculty of Engineering, Civil Engineering Department.

- **Master : ** 2021, Istanbul Gedik University, Institute of science and technology, Engineering Management (English) Program.

## PROFESSIONAL EXPERIENCE AND REWARDS PUBLICATIONS/PRESENTATIONS:

Ghaith R. Abdulghani and Ahmed Güllü, 2021. Building Information Modelling (BIM): Benefits for Small Scale Construction Industry. International Journal of Engineering and Management Research (IJEMR), Volume-11, Issue-4 (August 2021).

Ghaith R. Abdulghani, Zainab H. Mahdi, Mays R. Abdulghani, M.M. Kadhum, Investigation about the optimum alternative of polypropylene fibers in conventional concrete. Journal of Engineering Science and Technology (JESTEC), Volume 17, Issue-4 (August 2022).