Implementation of BIM in Small Dam Using Revit

By

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NATIONAL UNVERSITY OF SCIENCES AND TECHNOLOGY

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RISALPUR CAMPUS, PAKISTAN

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A thesis submitted to the National University of Sciences and Technology, Islamabad, in partial fulfillment of the requirements for the degree of

Bachelors of Science in

Civil Engineering

Supervisor: **Dr. Muhammad Sohail Anwar Malik**

National University of Sciences & Technology (NUST)

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FYP ACCEPTANCE CERTIFICATE

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This is to certify that the research work presented in this thesis, titled "**Implementation of BIM in Small Dams Using Revit** " was conducted by:

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No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the **Construction Engineering and Management Department, Military College of Engineering, Risalpur Campus** in partial fulfillment of the requirements for the degree of Bachelor of Science in Field of **Civil Engineering**.

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AUTHOR'S DECLARATION

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hereby state that my BS thesis titled "**Implementation of BIM in Small Dams Using Revit** " is our own work and has not been submitted previously by us for taking any degree from National University of Sciences and Technology, Islamabad or anywhere else in the country/ world.

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We solemnly declare that research work presented in the thesis titled "**Implementation of BIM in Small Dams Using Revit** " is solely our research work with no significant contribution from any other person. Small contribution/ help wherever taken has been duly acknowledged and that complete thesis has been written by us.

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Date: 17/05/2024

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

2D	2-Dimensional
3D	3-Dimensional
AEC	Architectural Engineer Construction
AIA	American Institute of Architects
BIM	Building Information Modeling
CAD	Computer Aided Design
CI	Construction Industry
CM	Construction Management
FM	Facility Management

LIST OF FIGURES

ABSTRACT

Small dams play a vital role in the development of every country and regions with water resource challenges. They have many benefits such as water storage and supply, flood control, energy generation etc. Despite having potential in all provinces, currently Pakistan has approximately 150 small dams, However according to the estimates, Pakistan needs approximately 750 more small dams to fulfill it water requirements.

Effective designing and execution of a project becomes difficult without following the principles and the guidelines of construction management . Designing of a construction project using conventional methods and techniques often leads to clashes between different stake holders thus resulting in delays in the project completion as well as an increase in cost. BIM (Building Information Modelling) has the solution to all these problems. It can not only model, collaborate and visualize but detect the clashes and produces reliable platform for resolution of these clashes.

This Final Year Project is aimed to analyze and validate the effectiveness of BIM in construction of small dams. The overarching goal was to enhance the efficiency, sustainability and economic viability of constructing small dams. Besides, changing the orthodox nature of construction, this study would help in providing guidelines for practical implementation of BIM in construction of small dams in Pakistan.

The BIM model of DAM was developed by different techniques and the best technique was carried on further for Modelling of the Toposurface and the Dam Components, When it comes to modeling dams, which often feature intricate geometry and require precise placement, Revit proves inadequate,. For such complex engineering tasks, it is advisable to utilize Civil 3D.

Keywords: BIM, DAM, Revit , Dam Modelling, 3D Model of Dam, BIM in Dams.

CHAPTER 1

INTRODUCTION

1.1 Background

Figure 1.1: Structure of a Dam

Small dams play a vital role in the development of a country with water resource challenges. They also serve various purposes and offer several advantages, particularly in rural and semi-arid regions.

Small dams are primarily built to store water, but they can be very useful in capturing and retaining rainwater runoff, which can be further used for various purposes, including agriculture, drinking water supply, and livestock. They provide a reliable source of water for crop cultivation, and also serve as a source of clean drinking water for local communities.

Small dams also help mitigate the impact of flash floods by temporarily holding excess rainwater and releasing it gradually, reducing downstream flooding and can also be used to harness hydro power for small-scale energy needs.When excess surface water is allowed to infiltrate into the ground behind a small dam, it can help recharge local aquifers, improving long-term groundwater availability.Furthermore, the construction and maintenance of small dams can create employment opportunities , stimulating economic development.

It is important to note that the construction and management of small dams should be done with careful consideration of environmental, social, and safety factors. Proper planning, engineering, and monitoring are essential to ensure that the benefits of small dams are realized without causing negative impacts on ecosystems or communities.

1.2 Problem Statement

Despite conducting multiple feasibility studies and having potential in all provinces the construction of small dams has been facing difficulties in Pakistan with regard to time and cost overruns mostly because of the use of conventional methods and techniques of management, which as a result causes clashes among various stakeholders and budget overruns. Currently Pakistan has approximately 150 small dams, however according to the estimates, Pakistan needs approximately 750 more small dams to fulfill its water requirements.

1.2 Scope

The scope of this research was to prepare BIM model of a small dam. The research was conducted through a literature review of existing studies and case study of different projects to determine the effectiveness of BIM in construction of small dams by providing a framework for the practical implementation of BIM in the construction of small dams.

1.4 Objectives

This project aims to modernize the construction of small dams in Pakistan by utilizing, analyzing and validating the effectiveness of BIM, which already has the solution to all these problems. The overarching goal is to enhance the efficiency, sustainability and economic viability of constructing small dams. It will be achieved through following objectives:

A. To develop methodologies for successful implementation of BIM in small dams.
B. To develop virtual architectural model of a dam using Autodesk Revit.

CHAPTER 2

LITERATURE REVIEW

2.1 The Critical Role of BIM Technology in Assessing the Cost for the Complex Dam Projects

The use of Building Information Modeling (BIM) technology and BIM software principles can be highly advantageous in estimating the costs of complex dam construction projects. The literature review includes::

2.1.1 Beneficial Use of BIM

The research indicates that the utilization of BIM technology and principles is significantly beneficial, practical, and helpful in estimating the budget of construction projects, particularly for large-scale dam projects such as the one studied in Iraq. BIM can help streamline the estimation process and improve its accuracy(Hussein Hasan.et al., (2023)).

2.1.2 Time and Cost Savings

Evaluating the cost of dam construction projects using BIM can lead to considerable savings in terms of time, effort, and budget. Dams are known for their complexity, lengthy construction periods, and challenging management, making the traditional estimation process time-consuming and costly. BIM can expedite the estimation process and help in optimizing resource allocation (Hussein Hasan.et al., (2023)).

2.1.3 Reduction of Human Errors

BIM techniques are found to significantly reduce human errors in cost calculations. This is crucial, especially in large-scale dam construction, where precision is essential. The use of BIM technology can lead to more accurate cost evaluations, ultimately contributing to better project management and financial control.

In summary, this research emphasizes the advantages of employing BIM technology and software principles in the estimation of dam construction costs. It highlights the potential for time and cost savings, increased accuracy, and reduced human errors. These findings can be valuable for project managers, engineers, and stakeholders involved in complex construction projects, particularly large-scale dams, where precision and efficient cost estimation are critical for project success (Hussein Hasan.et al., (2022)).

2.2 BIM Adoption Benefits

BIM is the new recognized ICT for integrated project documentation and information hence minimizing the data conflicts and better productivity in CI. (Bryde*et al*, 2013) carried out the analytical study on twenty (20) projects to sort out the benefits of BIM and formulated the following: control or reduction in cost and time,coordination improvement, collaboration and communication improvement andquality control. Furthermore, many researchers addressed the potentials of BIM for explicating financial and ecological implications simultaneously at early design stage (Z. Ma *et al*., 2012 & J. Basbagill *et al*., 2013). Current benefits of BIM as per United Kingdom (UK) government report (2012) are; about thirty eight (38) percentreduction in total construction project cost and nineteen (19) percent to forty (40) percent cost saving is expected from the design stage alone. BIM survey report (2013) states that the current BIM adoption rate in UK construction sector is thirty nine (39) percent.

Stanford University Center for Integrated Facilities Engineering (CIFE)identified the few noteworthy benefits based on thirty two (32) major projects usingBIM (CIFE, 2007):

- Up to forty (40) percent elimination of unnecessary work and unbudgeted change
- Cost estimation accuracy within three (3) percent
- Up to eighty (80) percent time saving in creation of cost estimate
- Up to ten (10) percent contract value saving due to clash detection
- Up to seven (7) percent reduction in construction time

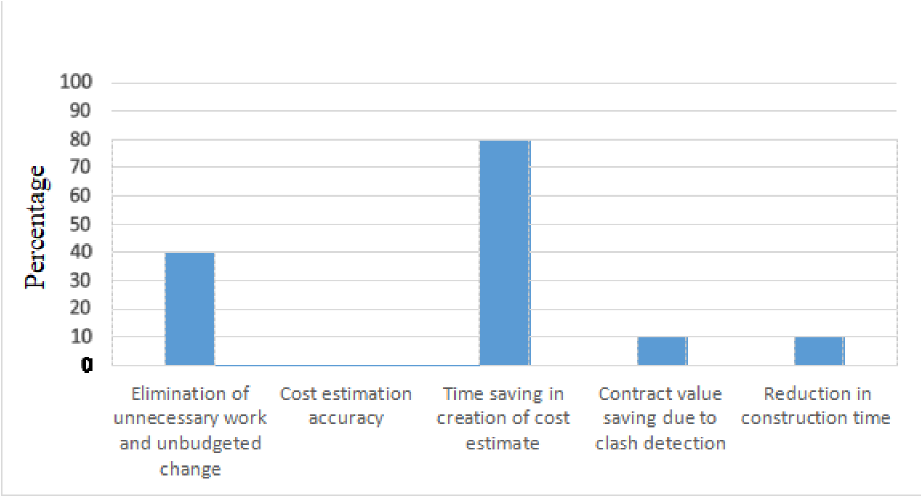


Figure 2.1: Benefits of BIM (CIFE, 2007)

BIM benefits from earlier conceptual stages through design, construction, lifecycle operation and maintenance are greatly recognized for all the three stakeholders i.e. owner, consultant and contractor.

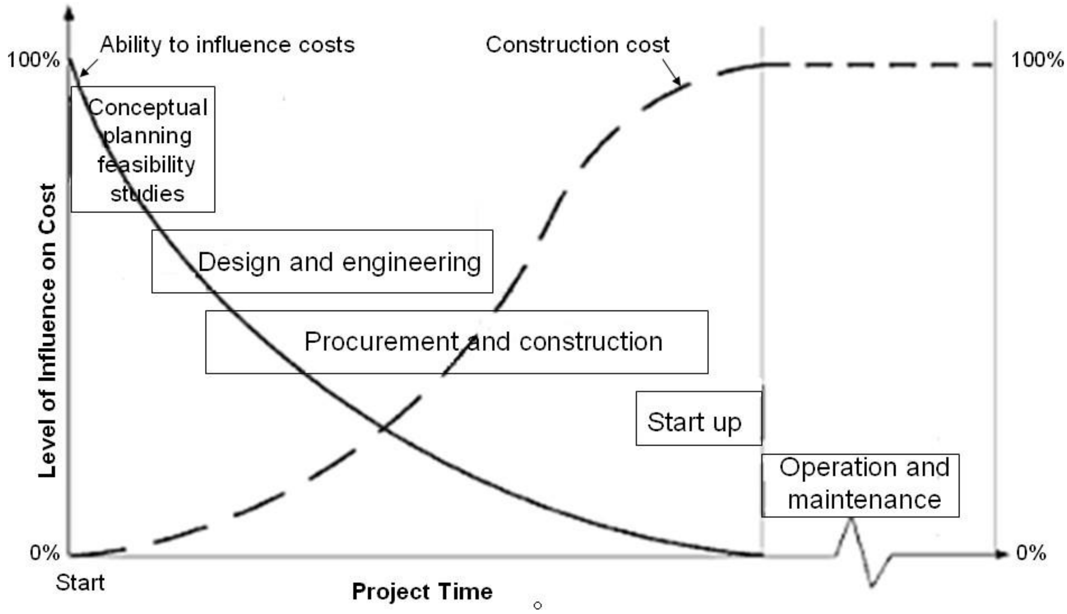


Figure 2.2: Project life cycle - ability to influence cost (Eastman, 2008)

2.2.1 Accurate 3D Visualization of Design

Parametrically accurate and consistent 3D model can be designed directly inBIM software which can be used for visualization at any stage of project. Earlier visualization of project is very important to owner, who is the main stake holder andwhose money is involved in all stages of construction. By 3D model visualization hecan actually see the final product which is going to be handed over to him. By 3D visualization he can make changes if he wants to do, in earlier stages of design, results in less change orders which ultimately save unbudgeted cost and time. 3D model visualization gives a very little room for any kind of misinterpretation by thestakeholders involved in the project and it also helps them to re-align their expectations (Salazar *et al*., (2006)).

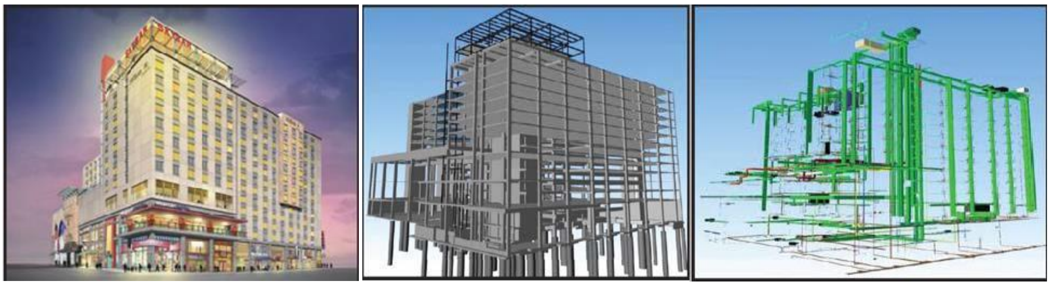


Figure 2.3: Architectural, structural and plumbing models of BIM

2.2.2 Interoperability: Collaboration across Multiple Disciplines and Organizations

BIM facilitates the simultaneous working of different design disciplines. Forworking in a team BIM have the ability to work on a single model saved as central model and the working models assigned to team members connected to the server. Any work done in working model is automatically updated to central model and at the end of the day one can extract the central model containing all the work. BIM allows the collaborations of coordinated models which shortens the design time andgreatly reduces the design errors. As contractors and consultants work on the same model and this model plays a mediating role between the two and designers can actmore rapidly on engineering problems faced by contractors and vice versa. Construction organizations are able to more clearly formulate their knowledge of construction problems and ask changes to the model that otherwise would have hadto be worked out in the field during construction or later 'with a hammer' (Taylor and Levitt, 2007). BIM gives the solution to minimize the disputes between the design and construction phase by providing a single digital environment in which both designer and contractor working their own way round. Computer model containing the rich information data of project can be handled from one contractor to the other in contracting out regimes.

In common situation, an architect would extract information from the modelsuch as HVAC pressure, wind direction, lighting analysis, and emergence under emergency situations, structural performance and budgetary feasibility, specialized skills and information would no longer be required for data input and result interpreting creating a closer linkage between design process and analysis (Autodesk, (2003)).

2.2.3 Clash Detection and Minimizing Conflicts

Clash detection is significant tool of BIM which can reduce the project timeand cost efficiently. As coordination between designer and contractor enhanced which lead to less chances of errors results in reduction of legal disputes and a smoother process for whole project team. Major hard and clearance clashes can be detected and highlighted by integrated all the key models together and checked for multi-system interfaces. Major and minor internal conflicts between the structural and MEP design systems can be detected and rectified at early design stages before fieldconstruction which can be a difficult challenge at construction phase. The solution can then be checked to ensure that it resolves the problem and to determine if it creates other, unintended, consequences (Ashcroft, H., (2006)).

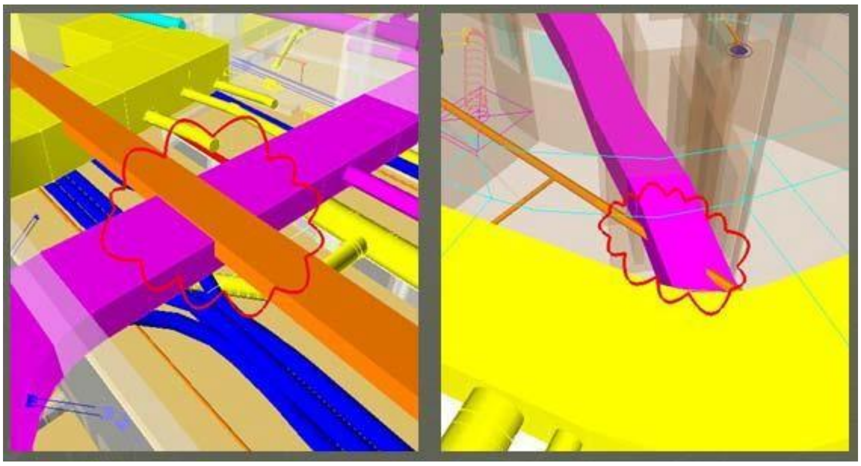


Figure 2.4: An illustration of clash detection via BIM

2.2.4 Quantities and Cost Estimation

BIM technology can be used to extract the Bill of Quantities (BOQs) at any stage of design. Quantities can be automatically take off in BIM software tools by using simple commands and used for cost estimation in design stages. BIM allows the automatically updating of quantities once change is made in model. As the design progress more detail quantities are generated and can be used for more detailed and accurate cost estimates. As stated earlier, up to eighty (80) percent cost saving can be achieved by using BIM technology. Final cost estimate with in the accuracy of three (3) percent, can be prepared based on quantities for all objects contained in the model at final design stage. This helps in making better decisions regarding cost and financial approaches to the project by using BIM technology rather than paper work.(Darren Olsen,et al., (2017)).

2.2.5 Energy Efficient and Sustainable Design

BIM allows one step ahead green building design by linking the created model to energy analysis tools for evaluation of energy. The capability to link the building model with various analysis tools can give more opportunities to increase the building's energy performance. Solar study carried at early design stages helps in elimination of modifications at construction stage and improves building quality. Lightning analysis can be done for energy efficient design and efficiently save the lightning cost by reducing electricity load (Farzad Jalaei and Ahmad Jrade, (2014)).

2.2.6 Construction Sequence and Planning

4D scheduling and sequencing in BIM allows the simulation whole construction process by linking the 3D objects in the design model with a construction plan. The simulation is done in a manner to show what building and construction site would look like at a particular point in time and provides considerable insight how the building will be constructed day by day and reveals the potential problems during construction related to cast and crew, equipment, safety problems and so forth. This type of simulation cannot be done with ordinary 2D and 3D software or paper work. Moreover temporary construction objects like cranes, scaffoldings etc. can be linked with the schedule activities and can be reflected in simulation.(Engbim, (2020)).

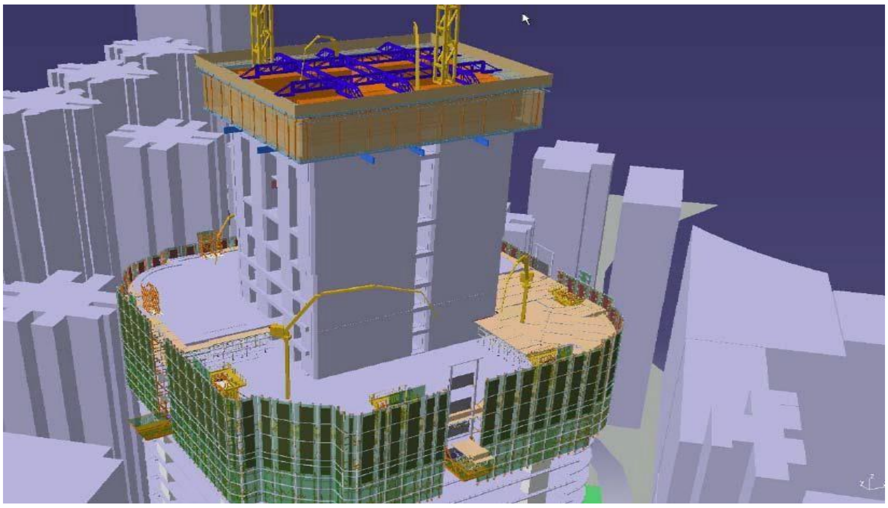


Figure 2.5: Construction sequencing model

2.2.7 Procurement of Materials

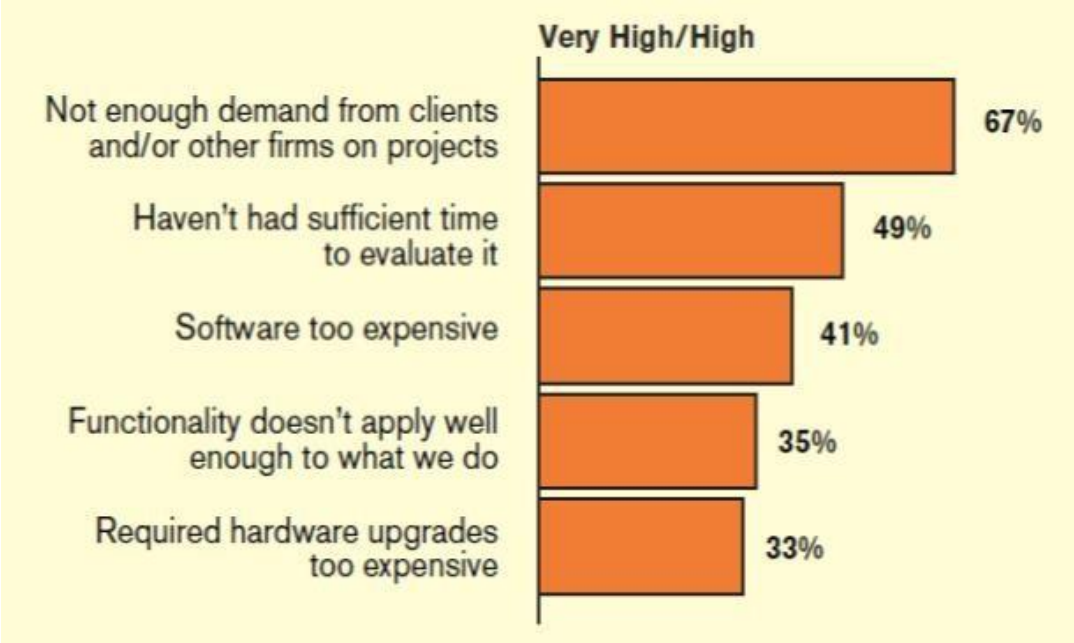
BIM can be used to design different kind of models shaped for product vendors and contractors. The quantities, specifications and properties provided for all materials and objects contained in complete building models can be used to procure materials from subcontractors and contractors. The major part of complete data that is included in BIM model comes from fabricators, subcontractors, supplier and vendors. The accuracy of the data acquired from the data is the same as the accuracy provided in making the model.

Since the BIM model contains all the vital details of every element in the construction, this facilitates off-site prefabrication. (andré monteir and João Poças Martins, (2012)).

2.3 BIM Adoption Barriers and Challenges

BIM is a thriving technology in AEC industry ready to bring huge change in whole construction process. As CI is very resilient to changes and very slow in adoption of any new technology. Initially BIM was not adopted by CI at a rate at which it was expected though now a days it is increasing exponentially. Barriers to the adoption of BIM can be categorize as business and legal issues, technical issues and organizational issues. (Imtiaz Iftikhar,et al., (2015)).

Figure 2.6: Most important obstacles to BIM adoption



2.3.1 Business And Legal Issues

2.3.1.1 Data Ownership And Risk Liability

Due to single complex project file, the legal issues involved with BIM and between working organizations are; who owns the multiple design, fabrication and datasets?, who financially support them?, and who is legally responsible for a faulty design?. The legal issues associated to BIM are identified by Ashcroft (2006) are
risk allocation, standard of care, privacy and third party reliance, economic loss doctrine, who is the designer?, Intellectual Property (IP), etc.

As BIM typically involves various architects and design professionals who contribute their expertise and IP to the creation of rich data model. This raises the question of ownership of the IP of model. Other issue is the risk and liability, who is responsible for any defect in the model and failure. As architects creating the seeds for whole BIM model, so (Frazer (2006)) evokes that it is possible to hold the architects responsible for any defect in the model as architects have IP rights.

Architects have shown reluctance in sharing their models due to risk and liability concerns. This made some contractors to develop their own construction phase models (Batcheler and Howell, (2005)). At later stages if there is any model that turns out to be defective, all the professionals would blame the original creator of work. This leads to unusual scenario that the architect initially creates the model would receive immediate benefits but greater risk and liability (Ashcroft, ((2006).

2.3.1.2 Data Privacy And Contractual Issues

As a single BIM model is a data rich database which leads to the issues of data privacy and secrets. The problem is also recognized by Drogemuller *et al*. (2006) who states that an auxiliary issue is the ability of firms in construction and FM to manage the shared data and databases. As the data in BIM model relates to the numerous parties involved in its development so contract must address the risk related to the databases in BIM model (CURT, (2006)).

Ashcroft (2006) argues that these new approaches will have to be developed to support the collaborative process within a system able to maintain design integrity and discipline.

2.3.1.3 Lack Of Standards And High Cost

BIM standards are in stage of development and no particular standards were defined. So lack of standards lead to ambiguities and legal issues but now people are working and some standard sets are defined and available to cover the issue raised in CI. Professional groups like American Institute of Architects (AIA) and Associated General Contractors are establishing new standard guidelines for contractual forms and language. Also the lack of client demand or market demand due to ignorance and low knowledge of technology and its benefits.

People in industry are not trained as professionals of BIM. If an organization tries to adopt the BIM technology they certainly have to train their employs and also have to buy the BIM software tools and highly efficient computer systems. All these approaches lead to high initial cost and investment. The process to obtain a high level of knowledge and expertise of this software is often very difficult and prohibitively expensive (Bazjanac, (2004)).

2.3.2 Technical Barriers

2.3.2.1 Interoperability

In BIM technology a shared building model is intensively used in all construction phases. As a base for whole construction process and collaboration, a set of coordinated building models is used during the process of design, construction and fabrication processes. In order to make a BIM project successful immense inter organizational coordination is needed. (Taylor and Levitt, (2007)) identified the same problem and states that for all construction firms it is important to implement 3D CAD and to adopt and work with same software tools or at least the same standards.

In CI the software vendors launch new and different innovative software tools in order to compete in industry. This make different design and construction firms to work with different software. Once the organizations using BIM, they have to coordinate because of using a single electronic design file throughout the construction process and this collaboration demands the same software by a single vendor or same standard software by any other vendor otherwise the whole structure of collaboration will fail. Files produced in one software format may not be able to open in other software tool which will lead to the failure and delay at any stage of construction. File converter software tools are available in market but actual file is viable to corruption or loss of any crucial data during conversion. So it is important for participating firms and organizations to switch to the same software before working on a project using BIM. Each organization should have the specialized software to perform BIM functionalities because inconsistent adoption pattern will lead to budgetary problems for prticipating organizations (London and Bavinton,(2006)).

2.3.3 Organizational Barriers

2.3.3.1 Lack Of Initiative And Training

Lack of initiative and training can be named as socio-technical issue related to the introduction of BIM. (Taylor and Levitt (2007)) also recognized this problem and stated that there is a little work in the way of providing guidance to the organizations, working in collaboration, about how to implement the BIM which requires a change in whole process.

Also there is no implication of BIM in educational community which results in untrained staff and graduates. Less or no knowledge about the BIM and cost associated with training is also a major factor.

2.3.3.2 Resistance Of Aec Industry To Change

CI is very resistant and slow to accept any change. It has been number of years people are preparing 2D drawings, manually and by using CAD programs, and working with it. They have their own expertise in this regard and they think they can easily learn and adopt current technologies while learning of new technology is very difficult and hectic work. Most of them are of opinion that if they are good with already available technologies and working satisfactorily then there is no need to learn and implement new technology. Due to these skill issues they are reluctant to any change in industry. For implementation of BIM organizations have to recruit trained and professional personal or existing staff have to be trained to the appropriate level which results in more cost. Construction firms will only able to successfully implement 3D CAD after they obtain sufficient training (Taylor and Levitt, (2007)).

CHAPTER 3

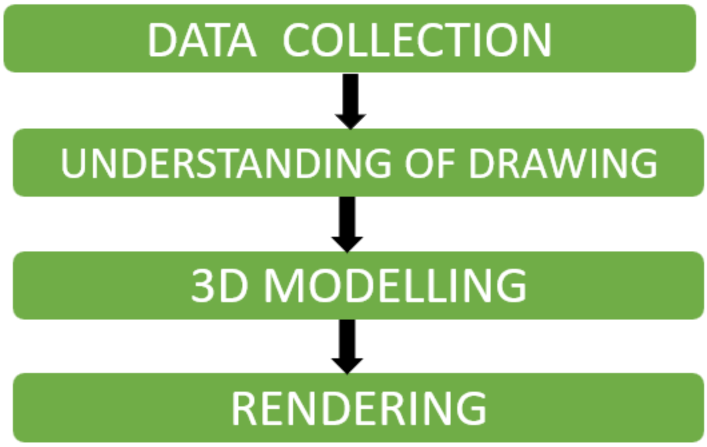
RESEARCH METHODOLOGY

3.1 General

The topic selected for our final year project is "Implementation of BIM in small Dams using Revit". This study concentrated on the implementation of BIM on a dam project to get better results than the traditional practices. This topic is selected due to research advancement and potential benefits of BIM for the construction industry. Following are the details of the dam selected for the final year project.

- The Jaroba dam site is located at about 1.5 km upstream of Jaroba village. The site is accessible by about 10 Km long metalled road separated from the main Pabbi-Cherat road at Aman Kot and about 1-1.5 km of subsequent walk.
- Northing and Easting of the dam site are 330 48' 44'' and 710 46' 36'' respectively.
- The dam is an Earthcore Rockfill structure (ECRD).
- The dam is about 585 ft. long and 115 ft. maximum height above Nullah bed.
- The embankment sections have 3H: 1V upstream slope and 2.5H: 1V downstream slope with crest width of 30 ft.
- The spillway is 85 ft wide with crest elevation at 2,155 ft a.m.s.l and is, designed against a 500 years return period flood discharge of 10,843 cusecs with a maximum flood surcharge of 11.2 ft.

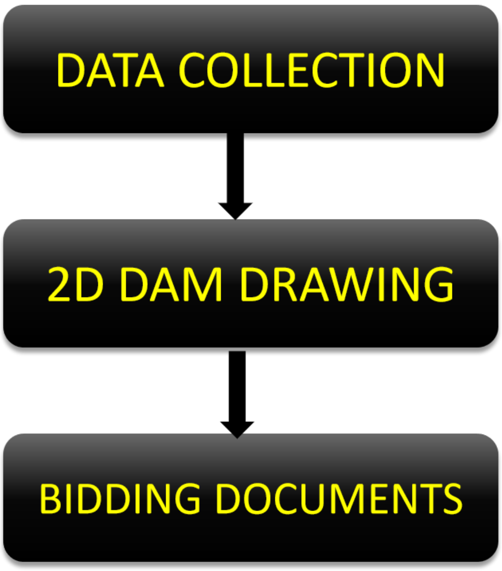
The procedure starts with the collection of the Data, which includes the 2D Working drawings of all the components of the Dam, followed by the understanding of the these Drawings. After this, the 3D modelling of the dams starts using the details as provided in the drawings carried on by the final finishing of the complete model.



Flowchart 1: General Working Sequence

3.2 Data Collection

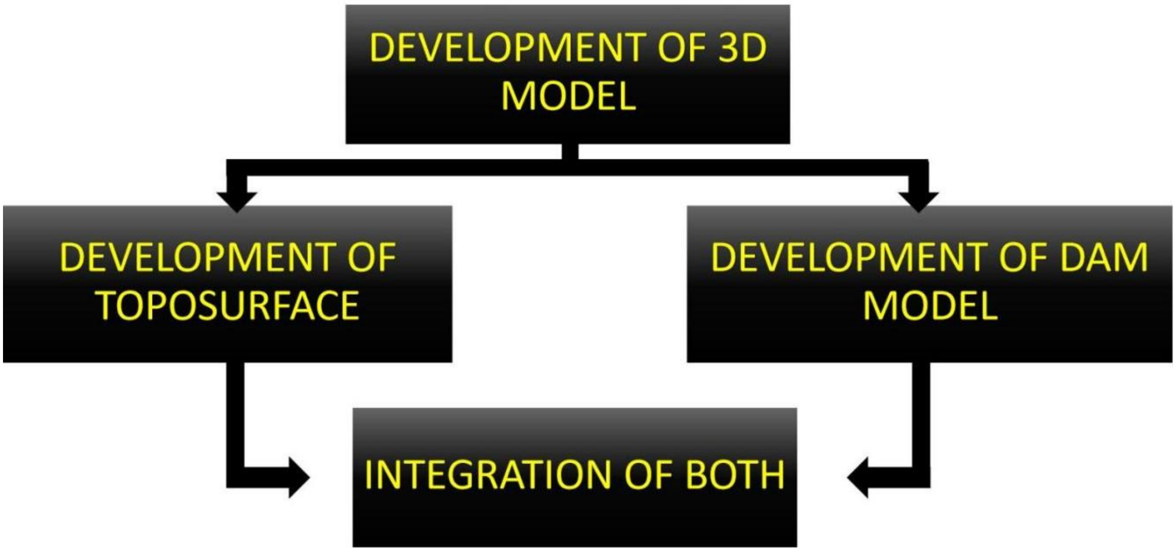
2D PDF drawings, BOQs and technical specifications of Jaroba dam were collected from Directorate General small dams KPK, which is a subsidiary of WAPDA in the region. The rest of the information regarding the project will be collected with the help of project advisor.



Flowchart 1: Flowchart showing the data to be collected

3.3 3D Modelling

After acquiring the data, 2D PDF drawings are imported into the Autodesk Revit. The 3D architectural model is be prepared first in two parts as shown in the flowchart below.

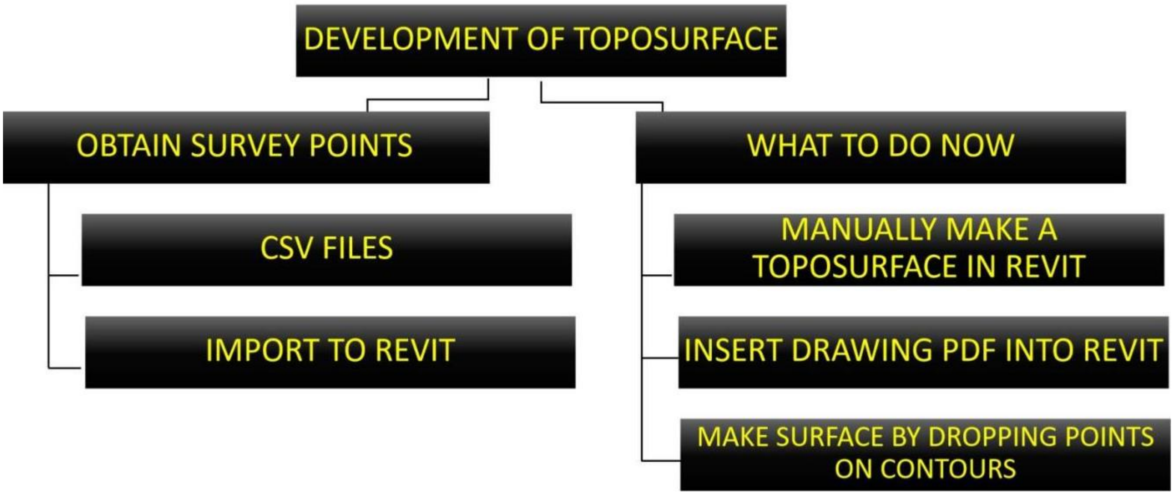


Flowchart 2: Development of 3d model

3.3.1 Development of Toposurface

The Toposurface can be modeled in the Revit either by getting the Original Survey Data (csv. files) of the site and directing importing the data points into the Revit.

If the Surveyed Data or the csv. files are not obtained and the toposurface of any site is to be developed through the pdf files, then there is a Second method in which the pdf file is first imported into the Revit and then the contour are traced manually by placing points and adjusting the height of the point according to the contour height given.



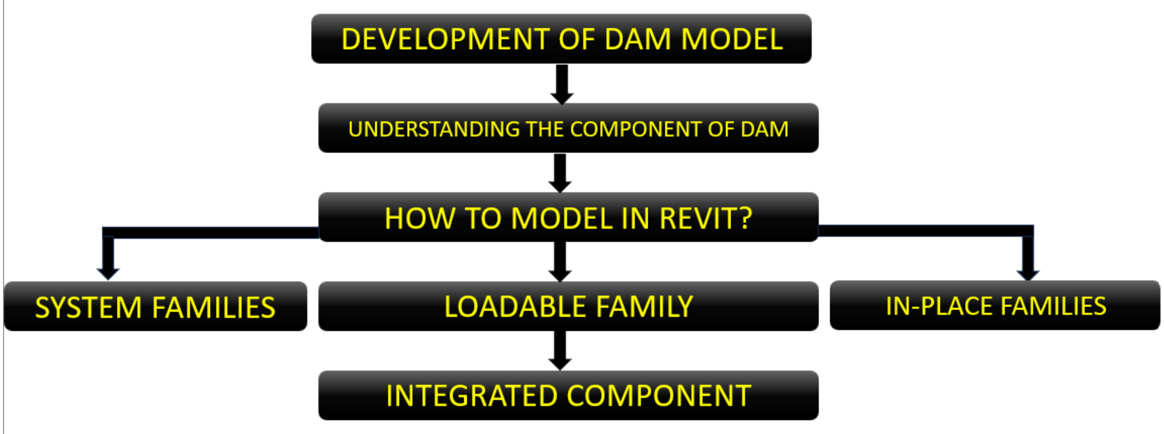
Flowchart 3: Development of Toposurface by both Methods

Step 2. Align the grids of the PDF with the manually placed grids in the revit. While placing grids, make sure that the distance between manually placed grids and the the distance between the grids in the PDF is same. This issue normally arises due to the difference in scale of the PDF imported into revit and the scale of the revit project.

Figure 3.3 shows the imported files in the Revit.In which we can see different counters and elevations and the dam.

3.3.2 Development of Dam Model

The model of the dam starts with understanding the components of the Dam first and then modelling it in Revit using the Appropriate approach.The model of the dam was made in Revit 2023, which was later updated to version 2024 while working on the model.



Flowchart 3: Development of Dam model.

When modeling in Revit, there are three approaches to get a Model, which are: System families, Loadable families and In-place families. Most of the elements that are made in projects are created in system families or loadable families. Loadable families can be combined to create nested and shared families. Custom elements(Non-standard elements) are created using in-place families.

3.3.2.1 System Families

System families create basic elements that are assembled on a construction site.

Some of the examples are: walls, roofs, Slabs and floors.

System settings, which affect the project environment and include types for levels, grids, drawing sheets, and viewport, are also system families. In Revit, the System families are predefined. You don't load them into your revit projects from external files and also they can't be saved in locations external to the project.

3.3.2.2 In-Place Families

when you need to create a unique component that is specific to the current project then use In-place elements as they are unique elements that you create . You can create In place geometry so that it references other project geometry, re-sizing or adjusting accordingly if the referenced geometry changes. When an in-place element is created, Revit creates a family for that In-place element, which contains a single family type.

The same Family Editor tools are used while creating an in-place as used in creating a loadable family.

3.3.2.3 Loadable Families

Loadable families are the families that are most commonly created and modified in Revit because of their highly customization nature. Unlike system families, loadable families are created in external RFA files and imported in your projects. Type Catalogs, which enable you to load only the types required for a project, can be created and used for loadable and used for loadable families that have a large number of types.

The scope of this project is not covered by the system families, therefore we have to create a component either in the loadable families or in-place families.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 General

The results of the project are illustrated below:

4.2 3D Modelling Results

After acquiring the data, 2D PDF drawings were imported into the Autodesk Revit. The 3D architectural model was prepared by first Developing the Toposurface, then Developing the 3D model of the Dam.

4.2.1 Development of Toposurface

The Toposurface of the site was developed by first importing the PDF file of contour drawings into Revit 2023 and then manually dropping points on contour lines with the given elevation of the contours in the PDF drawings. The following pictures depict the steps to make the toposurface.

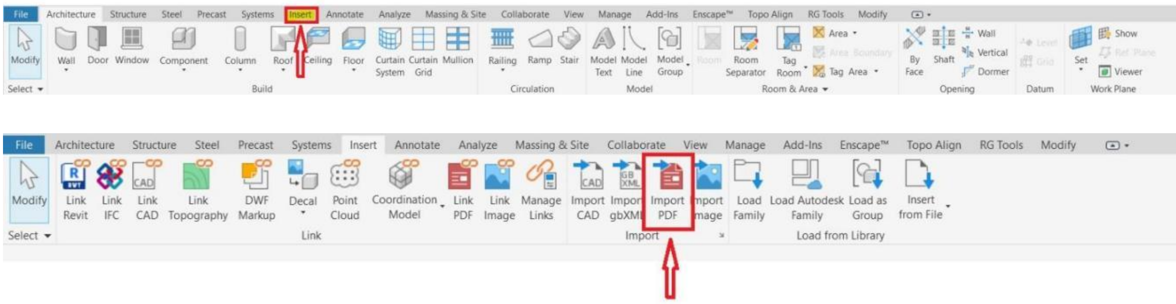


Figure 4.1: Importing PDF File

Step 1. Import PDF into Revit.

The given picture shows how to import the pictures in Revit. For this first go to the Insert in the main menu and then click on Import PDF.

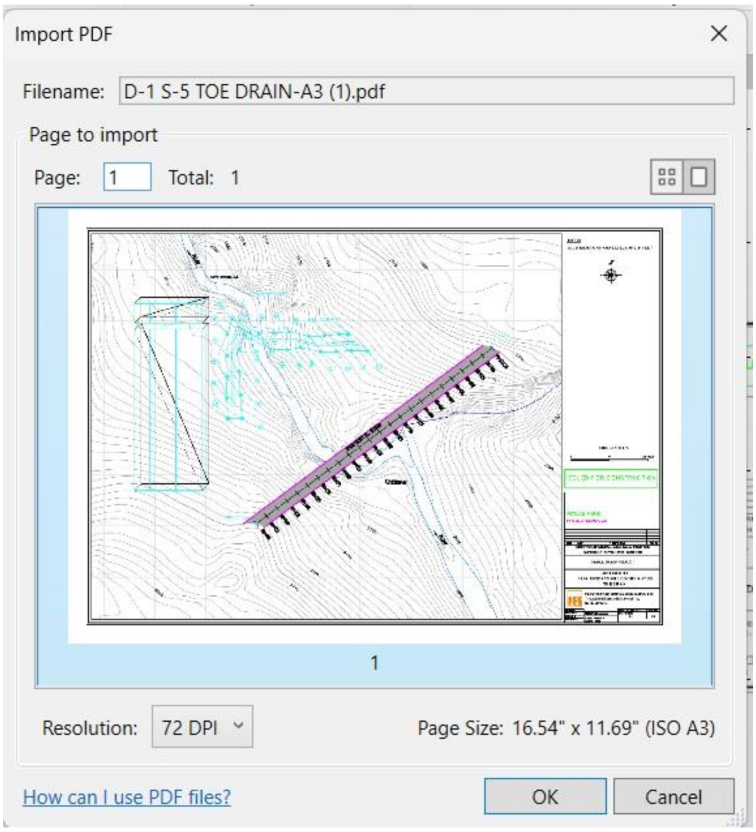


Figure 4.2: Interface of Importing PDF File

The above picture shows the interference of importing PDF files. For this you need to import the file as shown in the picture and set the resolution for this case we took Resolution of **72 DPI**.

Step 2. Align the grids of the PDF with the manually placed grids in the revit. While placing grids, make sure that the distance between manually placed grids and the the distance between the grids in the PDF is same. This issue normally arises due to the difference in scale of the PDF imported into revit and the scale of the revit project.

Figure 4.3 shows the imported files in the Revit. with the contours lines and contours lines of the surface.

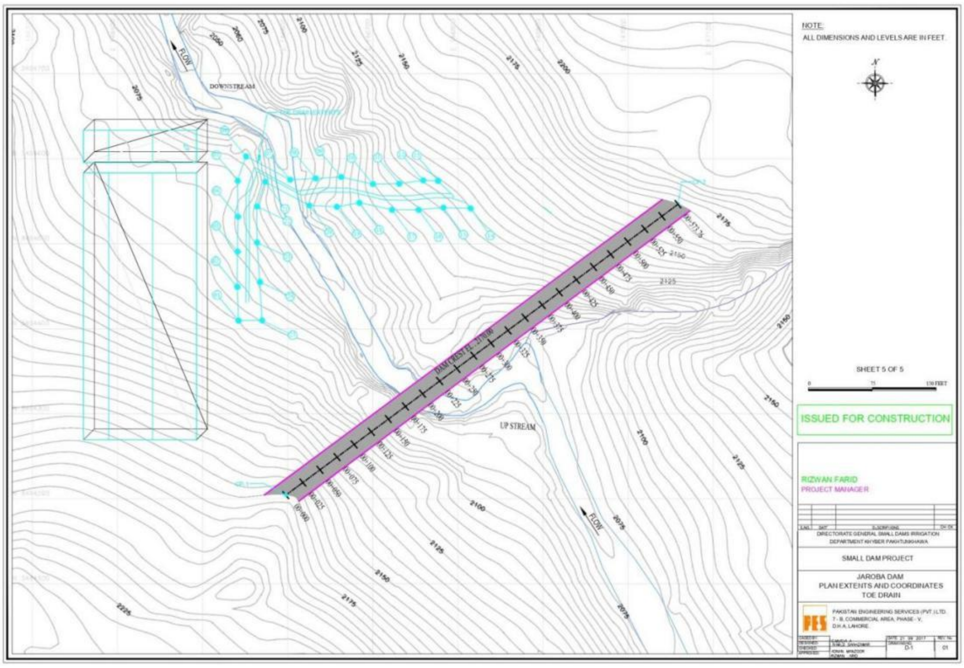


Figure 4.3: Imported PDF File in Revit

After importing the PDF files, the grid lines were placed on it and aligned with the grids of the file.

Step.3 Now make a toposurface by placing points manually on the contour lines with the given elevation of the contour in the PDF drawings. Repeat the process until all contour lines are traced. This will develop the toposurface.

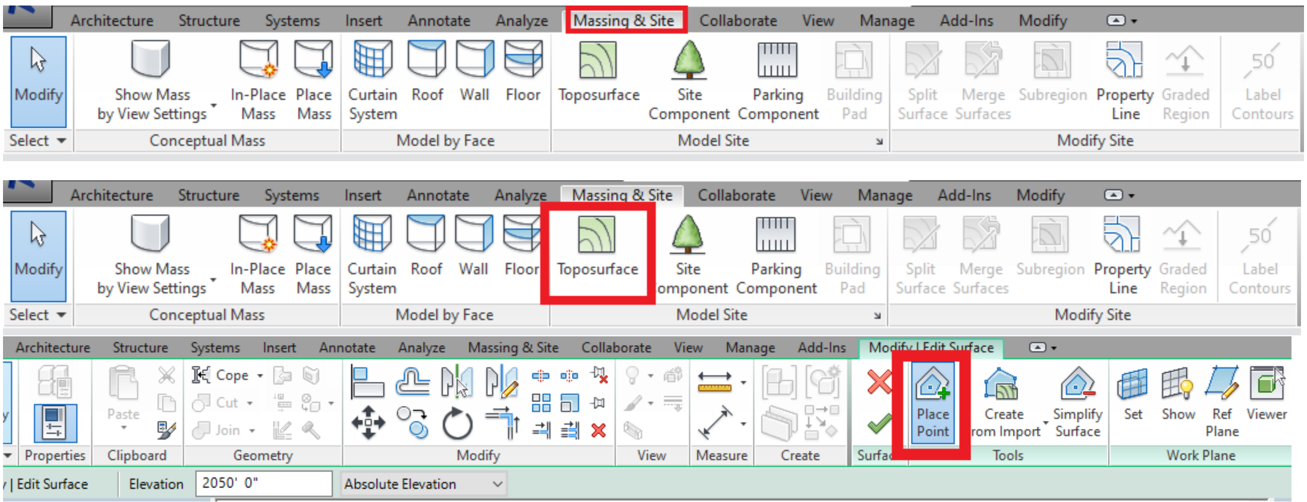


Figure 4.4: Tools for Placing Points on PDF to Draw Contours

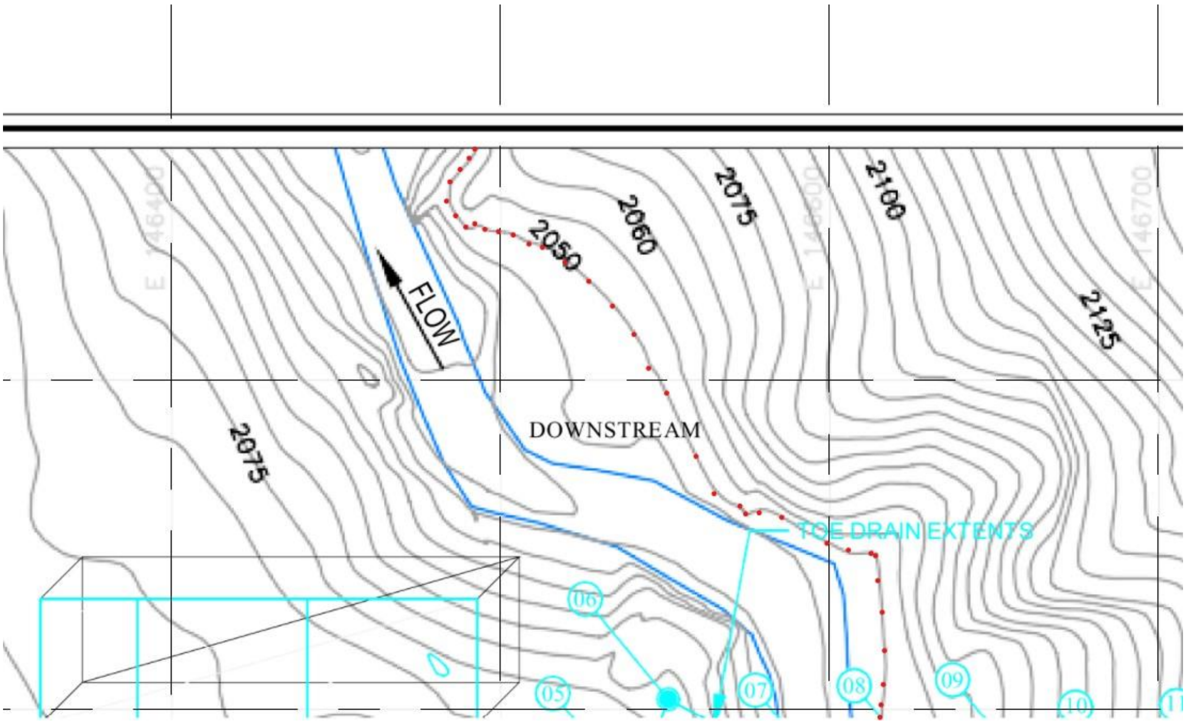


Figure 4.5: Contours to be Traced

The progress of the toposurface model after placing points of different elevations of the contours is shown below.

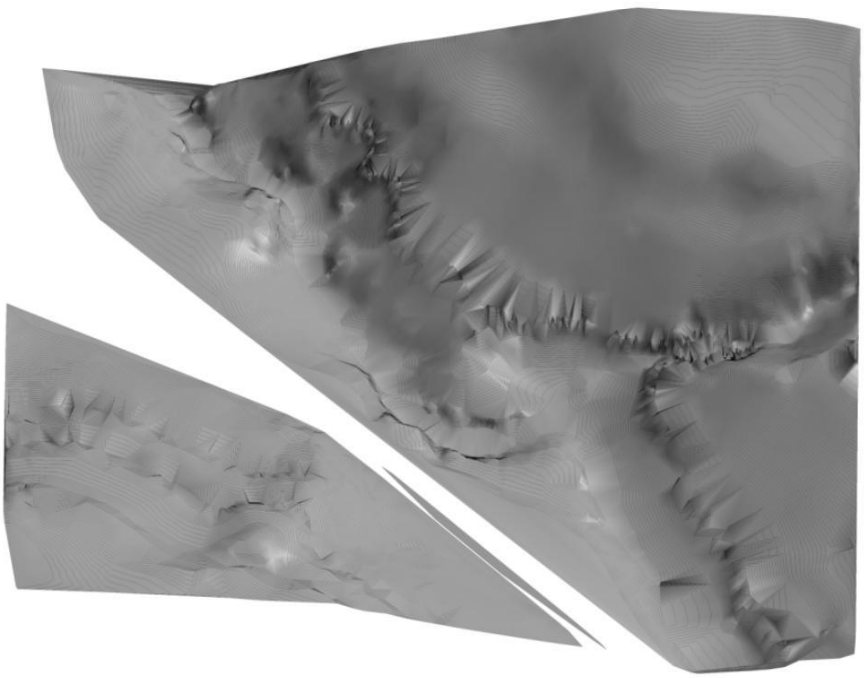


Figure 4.6: In process Traced Topography

Figure 4.7: Actual Toposurface of the Site

Figure 4.7 shows the actual Toposurface of the Site after the process of traced topography.

4.2.2 Modelling using in-place families

Due to the above mentioned advantages of in-place families we first modeled using in-place families. The steps to model using in-place families are shown below.

Figure 4.8 shows how to choose model in Place Family. For this select architecture and then select component and select Model In-Place from there.

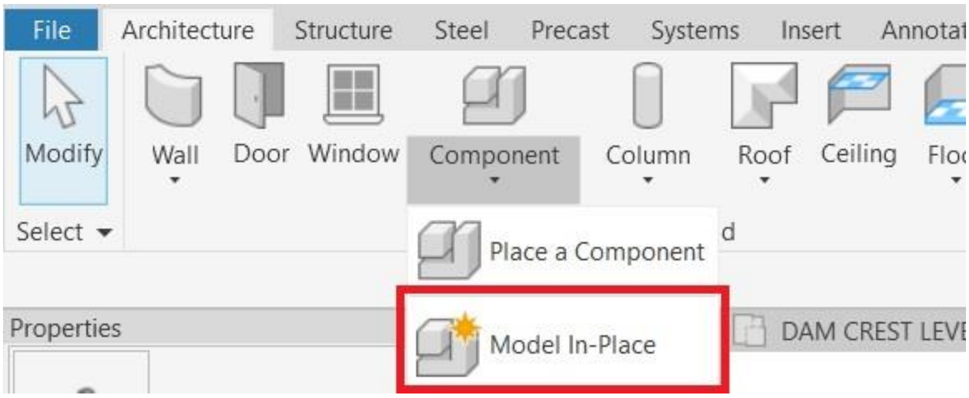


Figure 4.8: Choosing Model in Place Family

After completing the steps of figure 4.8 you will see a window popped up like figure 4.9a from which you can select the Generic models in Family.

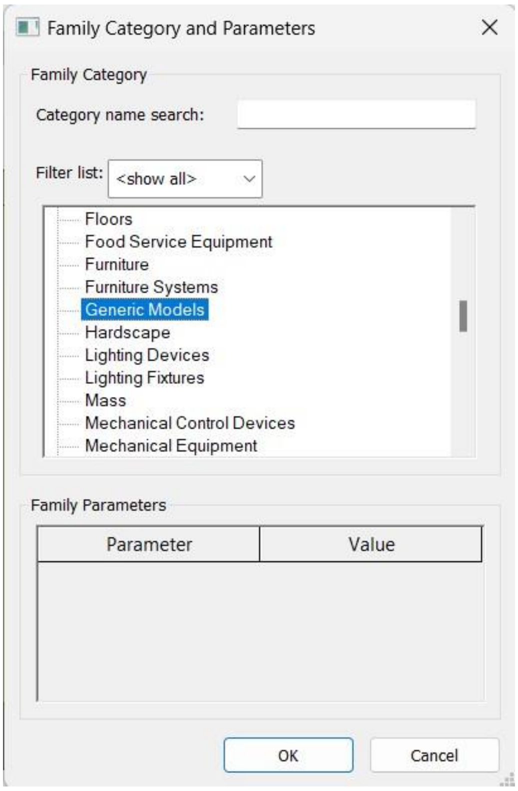


Figure 4.9a: Selecting Generic models in Family

Figure 4.10 shows the tools that can be used. To get these tools select the option modify / create extensions as shown in the figure there are a lot of tools available you can use any as required.

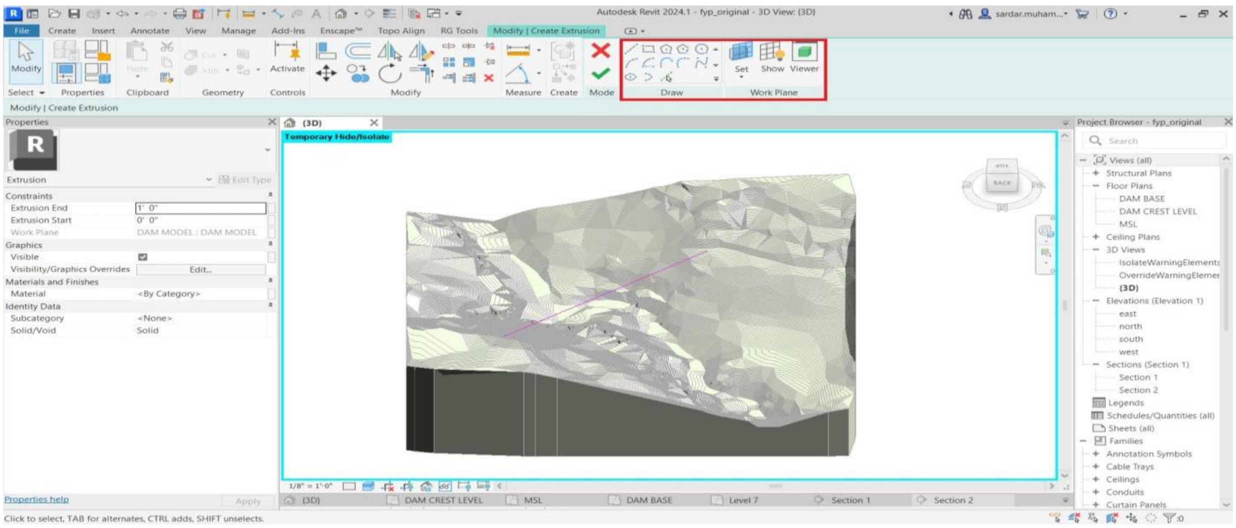


Figure 4.10: The tools that can be used

The results of this methodology are shown below in the figure 4.11. This figure shows the geometry of the model.

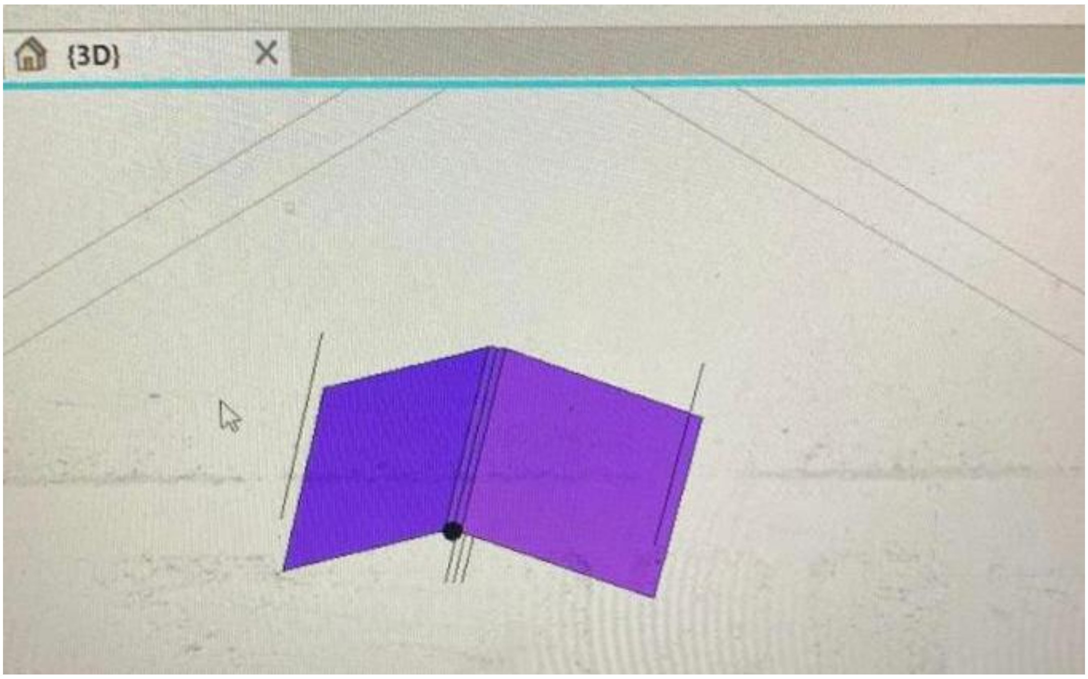


Figure 4.11: Geometry of the Model

The final results of this methodology are shown below in the figure 4.12. This figure shows the final geometry of the model.

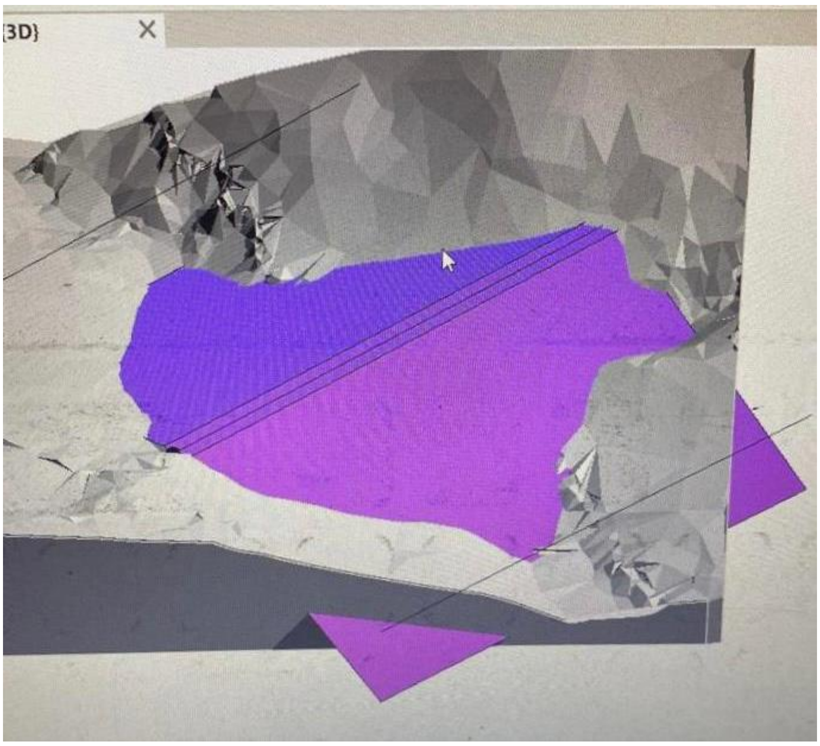


Figure 4.12: Final Geometry of the Model

When using in-place modelling although in-place geometry can be created which can be referenced to other geometry of the project, But the in-place geometry can only be placed on work planes as illustrated in the third picture and a closed geometry has to be created to create a solid form. This is not possible when working with complex geometry of dams.

4.2.3 Modelling using loadable family

When modelling using a loadable family although other project geometry is lost, But they can be customized in depth and can be later load into the project. The steps are illustrated below:

Figure 4.13 shows the procedure of selecting Loadable Families. For this go to Create and then select Family and then select Metric Generic model Adaptive.

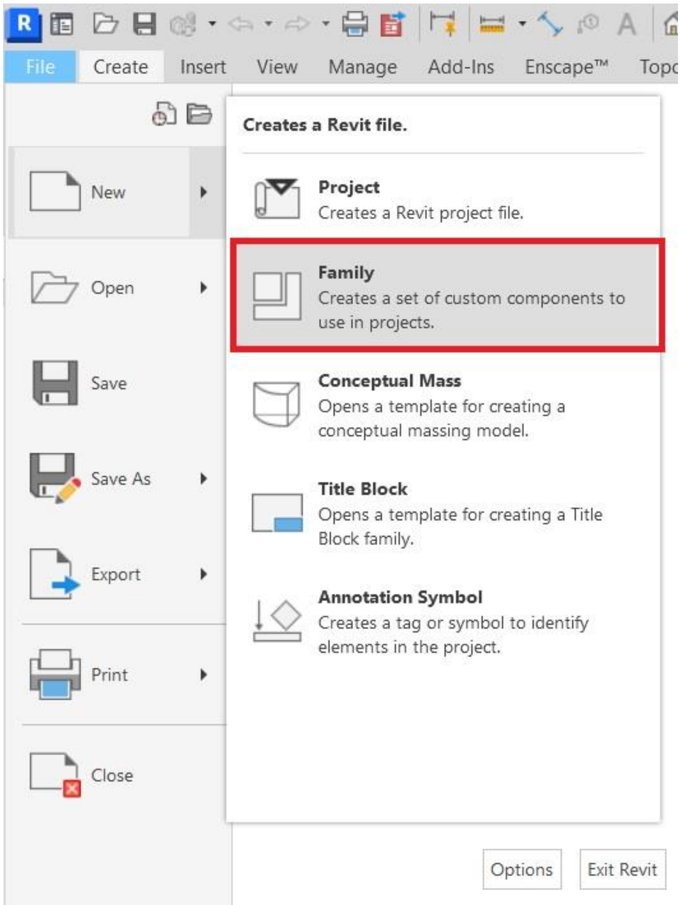


Figure 4.13(a) : Selecting Loadable Families

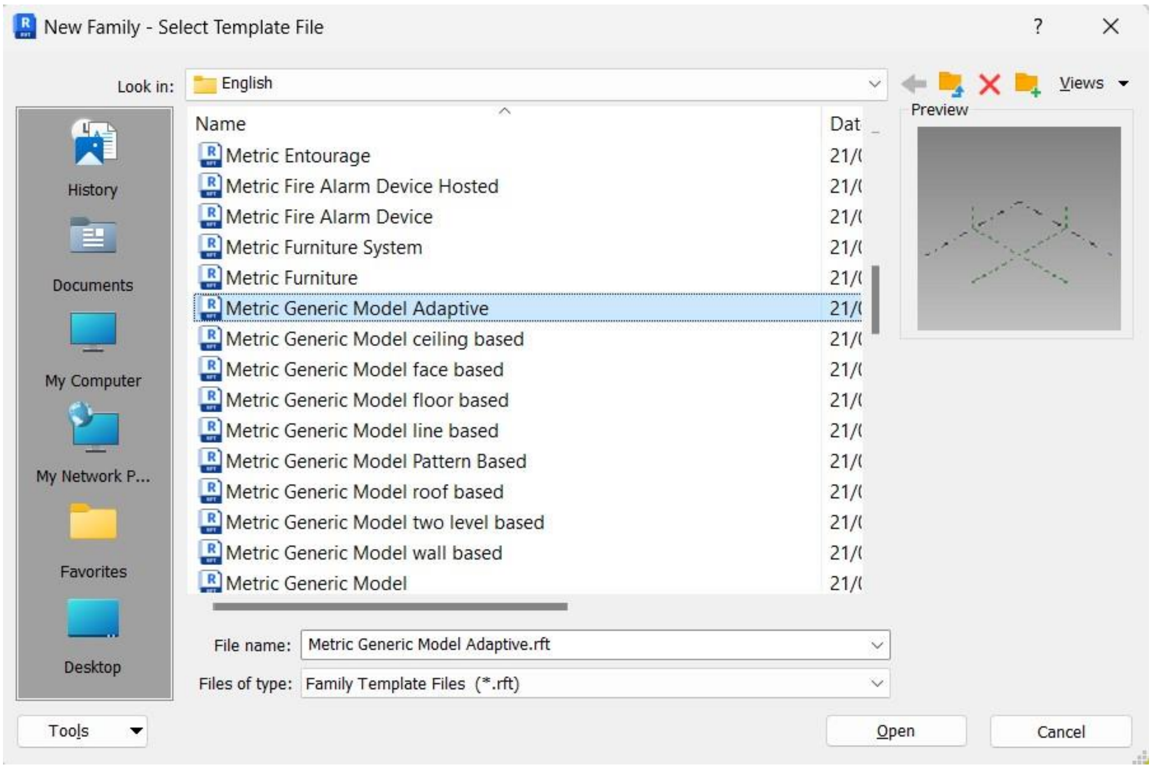


Figure 4.13(b) : Selecting Loadable Families

Revit has a lot of family templates by default for creating a new family, however when making a custom component GENERIC MODEL or CONCEPTUAL MASS is preferred. As the conceptual mass is generally used for conceptualizing buildings, After making an entire model of dam it led to errors.

Figure 4.14 shows the errors in loadable family approach in Autodesk Revit 2024.

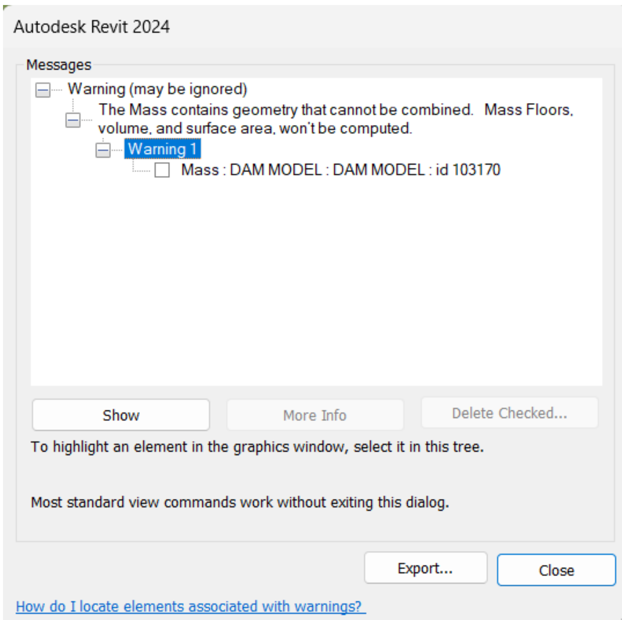


Figure 4.14: Error in Loadable Family Approach

After doing extensive research on Autodesk forums and making several models, It is concluded that making separate families of GENERIC MODEL template for each separate component of dam and combining them in separate families will not lead to any errors.

The progress of the model using this approach is shown below.

Figure 4.16 shows the Integrated model of Core and Filter Layers Components the first figure shows the filter layer while the second figure shows the main core of the dam.

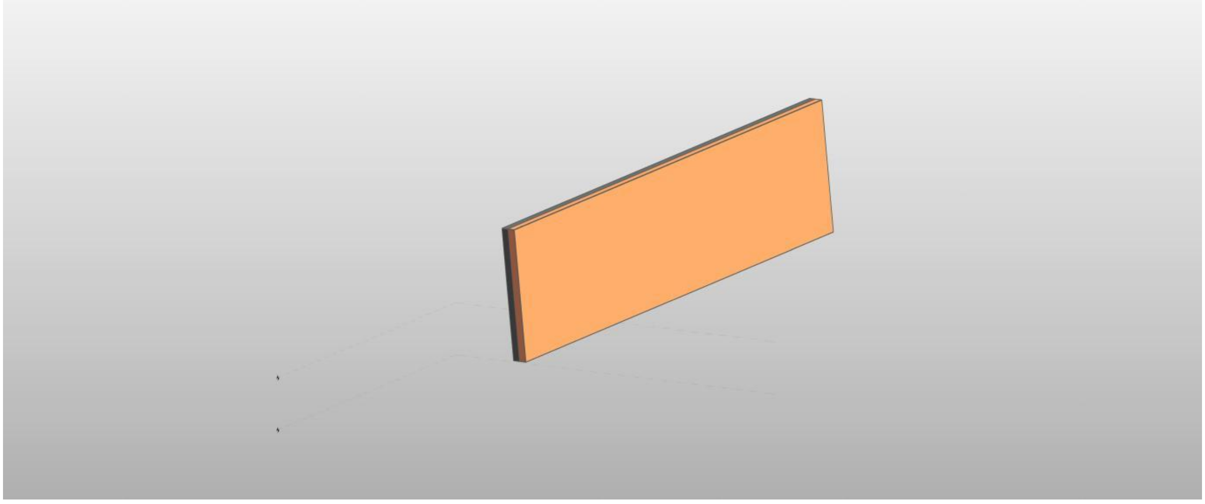


Figure 4.15: Model of Coarse and Fine filter Layers

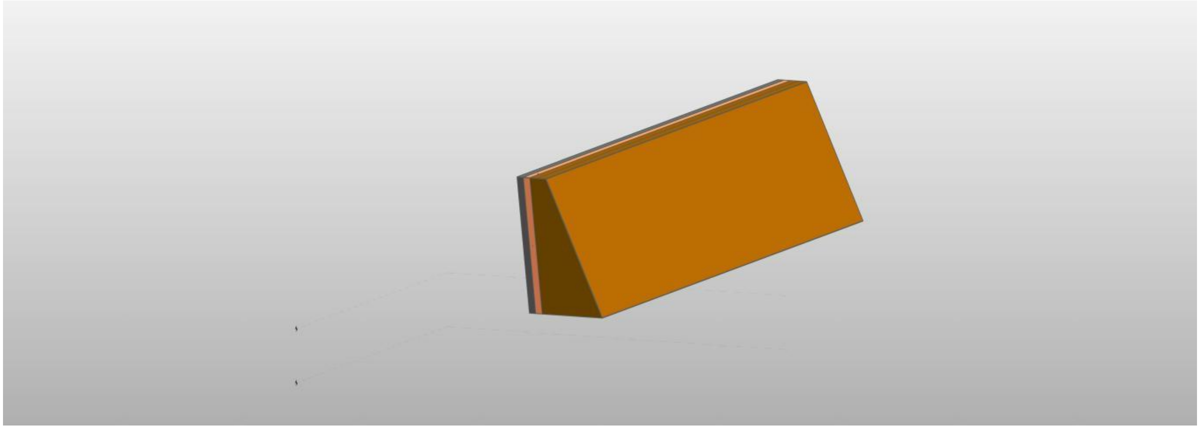


Figure 4.16: Integrated model of Core and Filter Layers Components

Figure 4.17 shows the Integrated model Showing Shell, Core and Filter Layers Components all of these were modeled separately and then integrated.

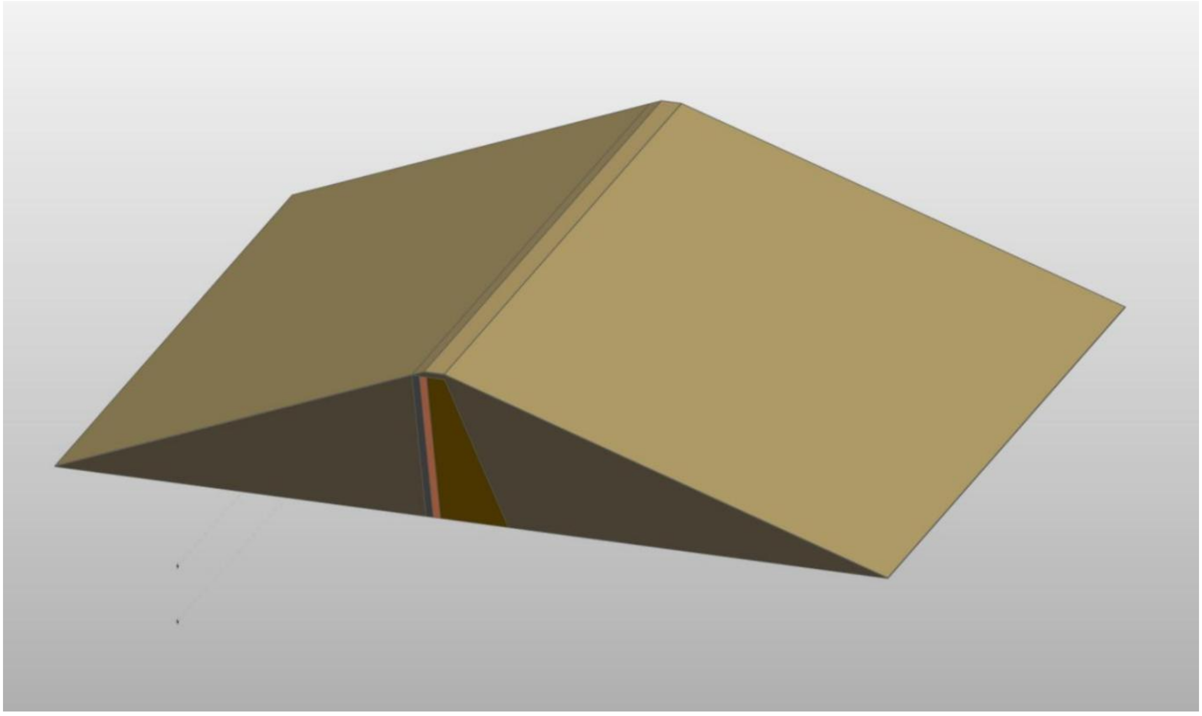


Figure 4.17(a): Integrated model Showing Shell, Core and Filter Layers Components

A layer of rip rap was provided over the Shell as per the design, the complete Integrated model including all the components of the Dam is shown below.

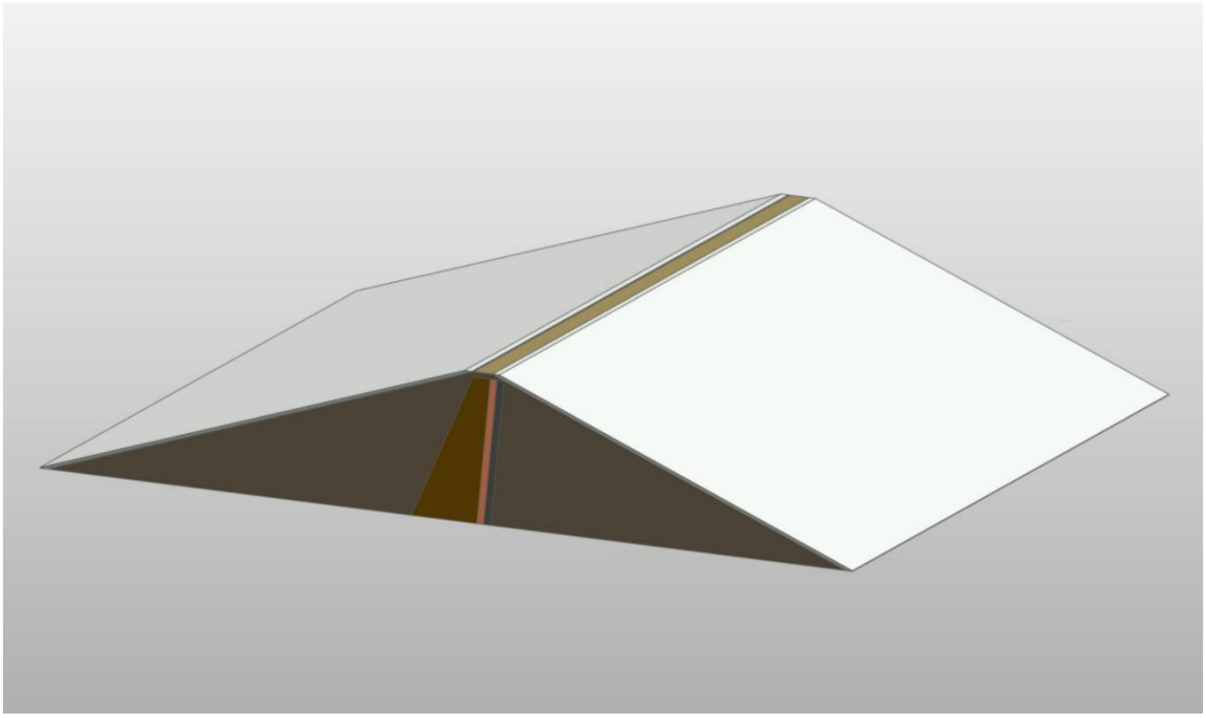


Figure 4.17(b): Model including the Rip Rap Layer

4.2.4 Integrated model of Dam

The Dam model and the topography were integrated together by Importing the dam model into the project and placing it at the exact original location. The following images show integrated models.

Figure 4.18.1 shows the integrated model placed on topography which shows the dam and its surroundings.

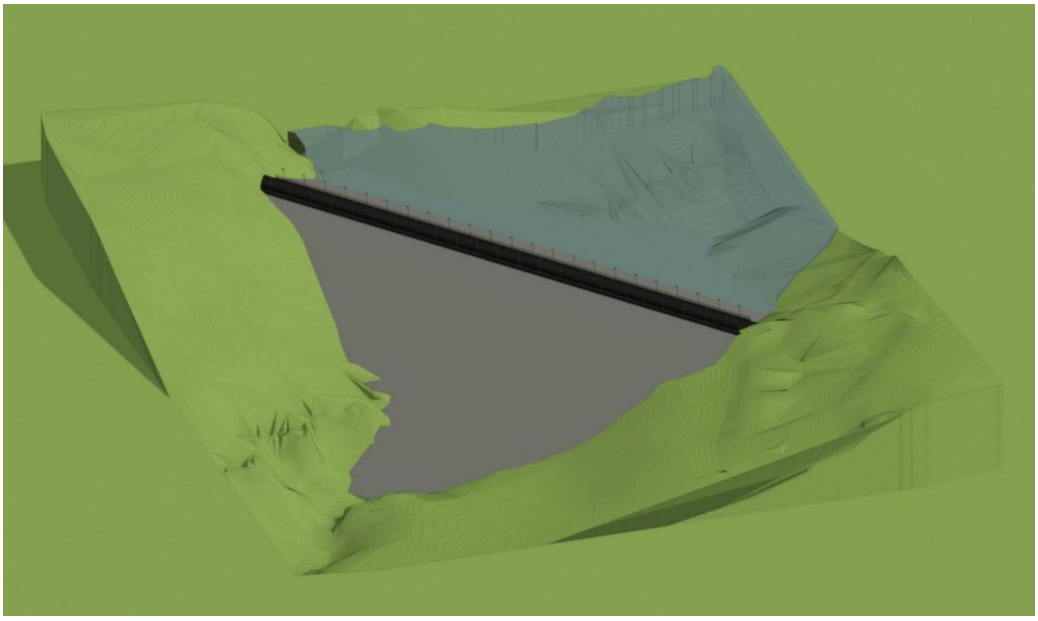


Figure 4.18.1(a) Integrated Model Placed on Topography

Figure 4.18.2 also shows the integrated model placed on topography which shows the dam and its surroundings. From a different angle

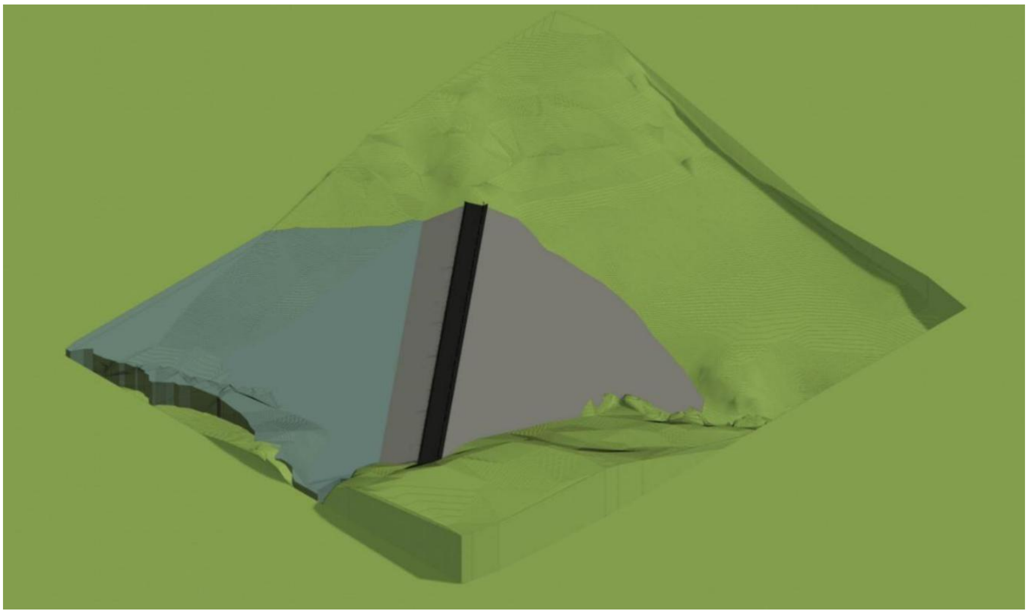


Figure 4.18.1(b) Integrated Model Placed on Topography

4.2.5 Comparison of L-section of Dam

Figure 4.19 shows the section of 3D model of DAM in the Revit, In this 3D model we can see the topography as well the passage of the water can also be seen in this.

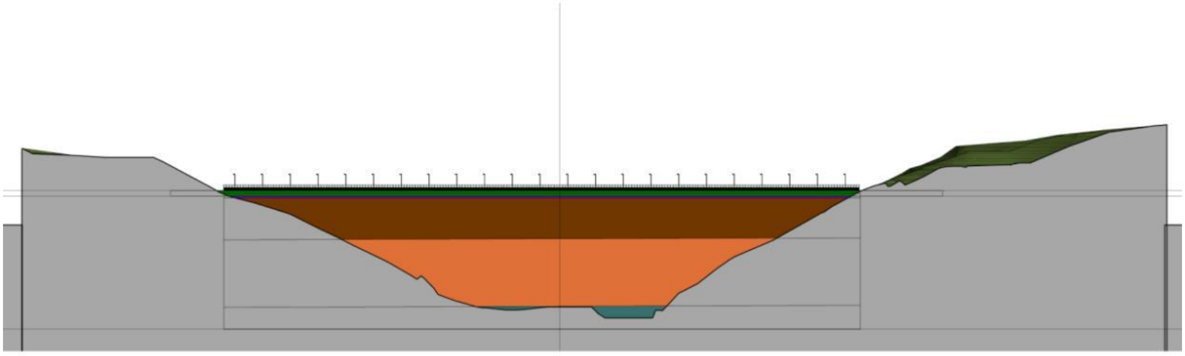


Figure 4.19: L-Section View of DAM 3D model in Revit

Figure 4.20 shows the actual L-section view which shows the NSL the stripping the dam level, core Trench.

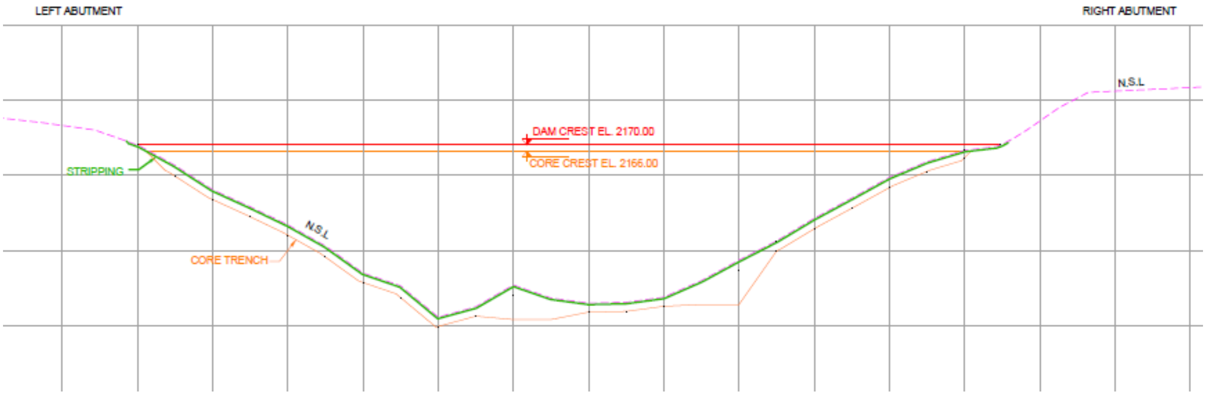


Figure 3.20: Actual L-Section View

4.2.6 Comparison of X-section of dam

The figures below shows the X-section view of 3D model of the DAM in the Revit and Actual X-Sec of DAM.

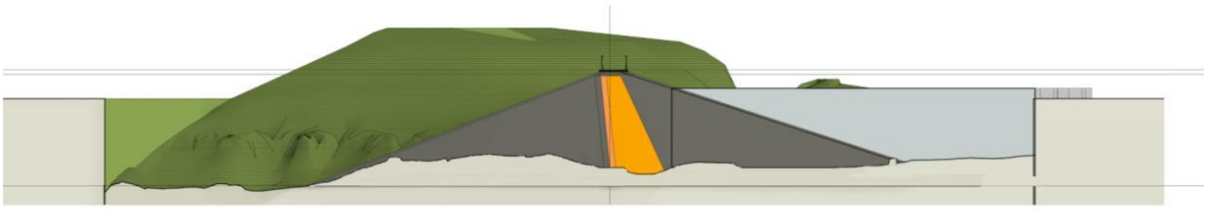


Figure 4.21: X-Section View of DAM 3D model in Revit

Figure 4.22 shows the actual X-section view of 3D model of the DAM in the Revit. This also shows Maximum elevation EL, Normal Conservation EL, Dead Storage EL, the DAM crest EL and Core and filter EL.

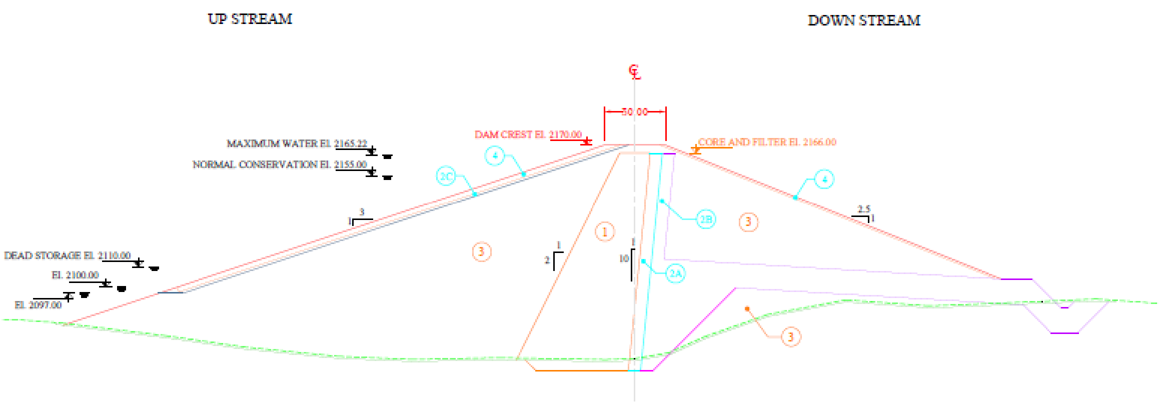


Figure 4.22: Actual X-Section View

4.2.7 Comparison of Top view of dam

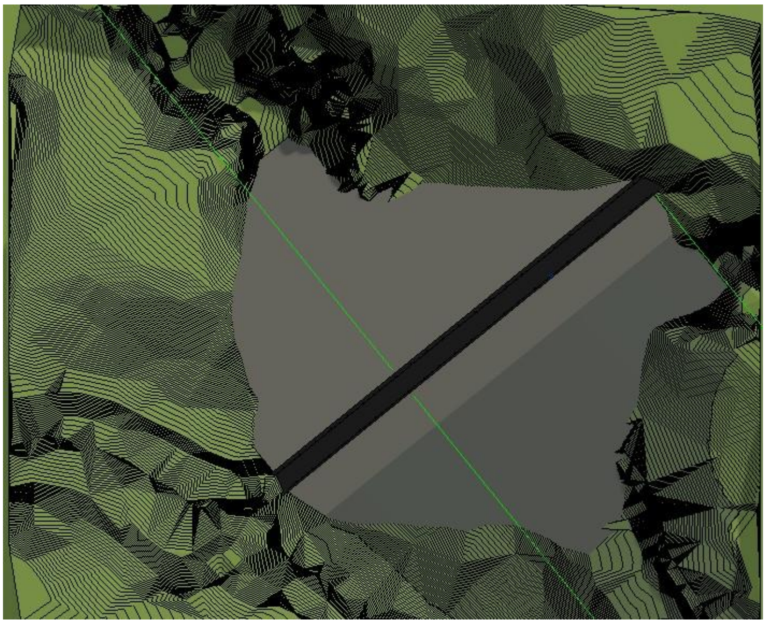


Figure 4.23 : Top view of 3D Model

Figure 4.24 shows the actual Boundary of DAM Structure. This also shows the contour lines in the upstream and the downstream, It also shows the flow path of the water.

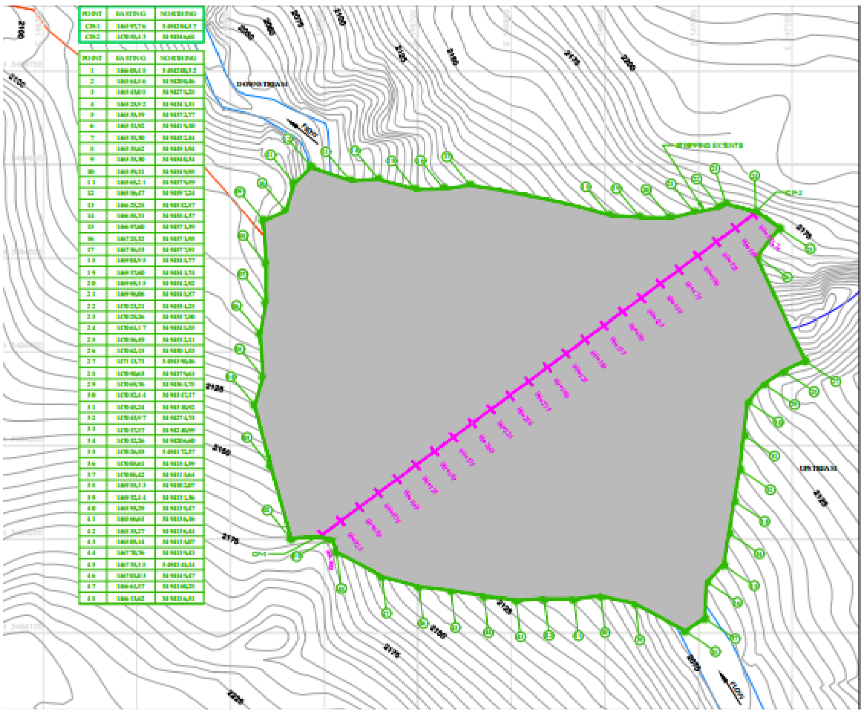


Figure 3.24: Actual Boundary of DAM Structure

From the above illustrated images it is apparent that the dam has been placed at its original location and visualized. However, the dam model and the toposurface overlap which could have been countered by using the cut geometry command, but the cut geometry command failed in this case. Which means that the dam model is not on top of the toposurface and the dam model would not depict the actual dam on site.

CHAPTER 5

CONCLUSIONS AN D RECOMMENDATIONS

5.1 Conclusions

In context of this project here are some conclusions.

5.1.1 Obtain .csv files

3D Modelling with 2D drawings of a dam becomes impractical in implementing BIM. Although a dam can be visualized and modeled to some accuracy and much of the geometry and data can be reproduced using this kind of information, However to depict an accurate model you need survey data or .csv files.

5.1.2 Revit

Revit is a 4D BIM capable 3d modelling software but it is mostly focused on architecture and works on horizontal and vertical workplaces which is the case in architecture. However in case of modelling dams with involves complex geometry and precise locations revit becomes useless in case of dams with added depth. It is recommended to use Civil 3D which is a powerful CAD software program that offers a wide range of features for civil engineering design. It includes tools for 2D and 3D drafting, surface modeling, land development, pipe networks, storm drainage, and much more. Civil 3D also integrates with other Autodesk products, such as AutoCAD and Autodesk Map 3D, to provide a comprehensive civil engineering design solution.

5.2 Recommendations

When it comes to modeling dams, which often feature intricate geometry and require precise placement, Revit proves inadequate, especially for projects involving significant depth. For such complex engineering tasks, it is advisable to utilize Civil 3D.
To depict an accurate 3D model of a Dam, .csv files and the survey data is required.

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