PRIMAVERA BASED PLANNING AND SCHEDULING OF A HIGHWAY PROJECT AND ITS INTEGRATION WITH BIM

FINAL YEAR PROJECT UG 2021

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This is to certify that the
Final Year Project Titled

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has been accepted towards the requirements
for the undergraduate degree
in
CIVIL ENGINEERING

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Dedication

Special dedication to our parents,
our supervisor, our friends, and
all faculty members

For supporting, encouraging, and believing in us, Thank you.

ACKNOWLEDGEMENT

All praise and thanks to Allah Almighty for blessing us with his countless bounties which enabled us to complete our project. We would also like to pay a debt of gratitude to our respected advisor Brig Dr Sarfraz whose patronage and exceptionally valuable guidance helped us in completing our project. We would like to extend our gratitude to our institution and the entire faculty who work tirelessly in helping us acquire the requisite tools and knowledge to become professional civil engineers. We have been blessed with a state-of-the-art BIM lab and an immaculate faculty of specialists, led by Lt Col Dr Rai Waqas. The efforts of MCE, Brig Dr Sarfraz and Lt Col Dr Rai Waqas in promoting BIM as a necessary tool of the future led to our inquisition in this particular field of study for our Final Year Project. Lastly, we would like to thank our beloved parents whose countless sacrifices and efforts have allowed us to achieve this success in life. We consider this as a stepping-stone in our future quest for practical manifestation of our research as a practicing engineer.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

With the advent of new technological advancements in the world we have a entered a new era of science and technology. Labour that took days to achieve can now be completed in comparatively shorter time periods. The adoption of these technological advancements has led to a massive increase in productivity and has introduced new cost-effective solutions to expensive problems. The overall efficiency of our lives and has increased and humanity is thriving now more than ever.

Similarly in Architecture, Engineering and Construction (AEC) Industry the adoption of these new techniques has led to the accomplishment of ground-breaking achievements. Many of these new methodologies have not widely been accepted and integrated within the industry due to the doubt surrounding construction practices. Due to this the industry has kept on with its conventional practices and hence have hindered further growth and progress of the industry.

The existing automation adopted has increased productivity, made processes more efficient and has reduced costs widely in the AEC Industry. Prior to the introduction of Computer Aided Design (CAD), the design of large-scale projects took months to complete, the introduction of CAD reduced this labour to a matter of weeks. The visualization of structures in three dimensions used to be very difficult, but with the use of modern CAD software's this has become very easy. Furthermore, introduction of structural analysis, construction scheduling, cost estimation, remote sensing, and GIS software's the industry has grown leaps and bounds. The structural integrity of a building can now be determined with just a click of a button.

The concept of CIM (Construction/Civil Information Modelling) is now becoming more and more apparent in the construction industry, Like BIM (Building Information Modelling) it has the capabilities to assist in the planning, construction, operation, and maintenance of any structures. Not limited as its predecessors were CIM's capabilities extend beyond conventional restraints as it goes beyond construction process and accounts for the management of cost and the operation of a project as well. By employing the CIM platform engineers, planners and architects can come together and collaborate on a single platform integrate their work. CIM promotes real time collaboration, planning and sharing information regarding a project, creating an interactive environment. The scale of a project on CIM can range from small building to a full-fledged town.

Under the widespread umbrella of CIM there are a variety of software's available each with its own capabilities, all of whom are linked to each other and who's data can be shared in between them. The process of three-dimensional modelling is an example whereby either manual input or using GPS technologies 3-D models of a highway can be generated and studied, similarly by using similar methods we can prepare and study cross-sections of a road as well. Availability of platforms for cost estimation has reduced strenuous manual labour and has helped minimised human error in calculations as well. This has enhanced the planning phase as well the execution of projects as well.

1.2 RESEARCH QUESTIONS

The Research questions are as follows:

- What are the operations and activities involve in highway construction?
- How are the operations and activities stimulated and integrated in CIM (Construction Information modelling)?
- How much BIM application is helpful in road development plan and execution, all things considered?
- What is the latest trend in information modeling in Highway construction?
- What developed CIM software can be utilized in planning of highway construction project?

1.3 OBJECTIVES:

The main objective of this research project is to try and map out a system that would improve the efficiency of the construction industry in general by creating an environment in which planning, design and execution processes can be aided using BIM. This project is directed towards taking the concept and approach of building information modelling (BIM) and extending it towards infrastructure and utilities of a road. A 3D model that is constituting all utilities and services loaded with engineering design information. The objectives can be listed as following:

- Application of BIM to highway construction.
- To plan, schedule, and develop a structural 3D model of a highway, Lahore Ring Road's Southern Loop (SL-1).
- To develop a process of integrating Primavera based schedules with BIM.
- To Develop a comparative matrix between BIM integrated projects and Primavera alone.

1.4 AREAS OF APPLICATION

This research will mainly focus on scheduling and planning of a Highway through Primavera (P6) and Building Information Modeling (BIM) using advanced process of scheduling which allows integration of 3D model with schedule and cost to generates a simulated video which is like seeing the project being built in real. This research aims to analyze effectiveness of BIM in infrastructure projects. Our area of research is the Southern Loop, SL-I of Lahore Ring Road, "SL-I (9.35 km): Starts from Sui Gas Town and finishes at Ferozepur Road. The arrangement goes through Kamahan town, crosses the Hadiara channel and finishes at interchange to be developed at GajjuMattah on Ferozepur Road."

1.5 OUTCOMES

- The main argument on which this thesis resides was to recreate the existing highway using CIM (Civil information modeling), and to compare it with Primavera P6, the software which is widely used in Pakistan and of which there are many experts available, but there is a need to adopt BIM. As for transportation the efforts to incorporate the new technology has not been comprehensive so far.
- BIM enhances the planning process, design, and overall span of construction of a highway by providing digital representation of the construction process, hence providing critical information of hazards, design clashes at the very start of the project when the problem in viable to be solved.
- Designing an infrastructure on a BIM platform effectively supplies the on-site construction data of a highway project with the help of Infraworks, Civil 3D, Navisworks and other Autodesk software available in the BIM environment. Furthermore, the BIM environment helps decide the methodology of constructing a project in a real time visualization. Therefore, BIM contains all the information concerned in a biorhythm of a project.

- This research focuses on the adoption of BIM for highway construction. As for the main study the orientation is more towards the existing highways and managing its life cycle for rehabilitation and renovation when required or induced by some natural disaster or mishap. Recreation of a highway in BIM with primary focus on comparing the key delivery process of scheduling with Primavera P6 on which it was originally scheduled. BIM used for real time rescheduling of a highway and highlighting flaws of timeline of construction that was planned on a single software will encourage engineers and designers to bend towards the demanding technology of the world. Digital modeling and cost evaluation are also poked, and the idea of how BIM is far better approach than Primavera for scheduling is sold. How, the wholesome space, BIM, is better than Primavera P6 and what difference it makes to plan a project using BIM is to be highlighted at the end of report by a case study of a highway in Lahore, Pakistan.

1.6 SCOPE

The scope of our project is to take a highway which has already been scheduled in Primavera and then integrate it with BIM and have an analysis of the requirement and significance of this integration that why it must be adopted.

1.7 METHODOLOGY

The methodology for the project is as shown:

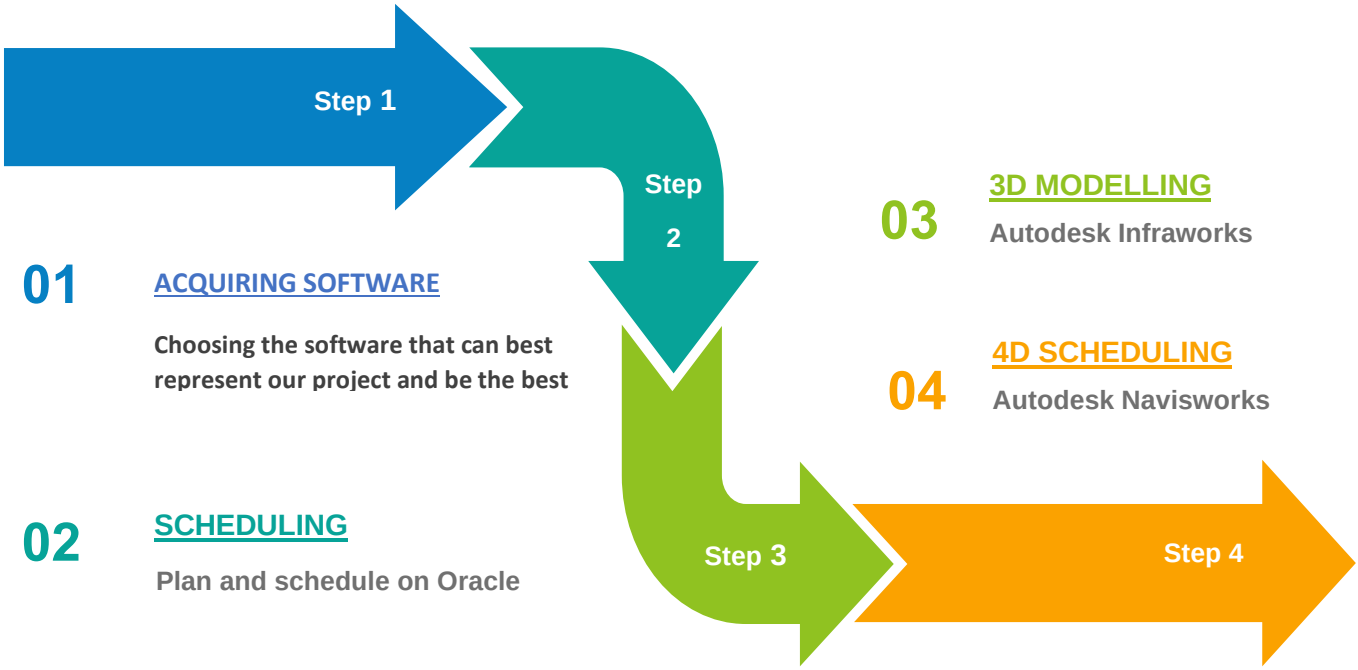


Figure 1: Project Methodology

1.8 REPORT ORGANISATION

The report has been organized as follows:

- CHAPTER 1: INTRODUCTION
  The introduction covers a brief overview of the complete project with introduction to Building Information Modeling and Civil Information Modeling, followed by research questions, outcomes, area of application, scope, objectives, and methodology adopted.

- CHAPTER 2: LITERATURE REVIEW
  It covers all the work that has already been done in relation to our scope. Mainly Primavera based scheduling and Building Information Modeling has been explained along with its benefits, tools, and applications.

- CHAPTER 3: METHODOLOGY
  It consists of a detailed procedure having all the steps explained of different software required to attain the final 4D model. It covers methods and techniques used to integrate a simple primavera schedule with BIM.

- CHAPTER 4: RESULT AND ANALYSIS
  The results have been summarized in it and have been analyzed as if they were as per our expectations and assumptions or not.

- CHAPTER 5: CONCLUSION AND RECOMMENDATIONS
  Finally, the project is concluded. The conclusions have been oriented in respect to our objectives defined in the beginning.

CHAPTER 2: LITERATURE REVIEW

OVERVIEW:

- All previous work that has been done in context to our project.
- Overview of scheduling on primavera
- Introduction to BIM.

2.1 PRIMAVERA BASED SCHEDULING

Road construction projects particularly or any civil projects are time dependent. Their main achievement is to proceed towards the closure in the bounded time with all the objectives, scope and, quality defined in the planning phase, respectively. Cost and time invasions are the two main troubles faced in every project, because a small delay in the critical activity; as many activities are in process simultaneously; can infect the main scheme leading time and cost to scraps. Therefore, efficient time planning is the only key to a successful project. Delineated below are the five main components of Primavera based projects which are of prime importance and must be carried throughout the lifecycle of the project.

Planning and Scheduling: -

Developing and scheduling are comprised of this stage. The goal is to execute the project in the specified time and to apply remedial alterations to the activities which keep the life cycle bounded in the time frame. As we look this component in a broader sense, it is basically the time management for functions and activities of a project.

Time and Cost Control: -

Completing the project in time and managing the scheduled sequence of activities, becoming a master of multitasking is referred to as time controlling the tasks in the allotted time, time control. Whereas budgeting and keeping the project in the budget ensuring all the quality aspects are summed up in cost control in managing the whole construction.

Primavera Software: -

The Primavera P6 software is inputted with activities in sequence with their start and finish time, and software threads these activities to make a critical path, which the project manager strictly follows. This all is obtained from its feature of scheduling.

Scope of the Project Work: -

1. An exemplary construction process for a highway is laid down.
2. A contingency plan is also prepared for every sequence of activities.
3. Consumption of time and capital optimized for maintaining the standards of the project.

Objective of the Study: -

Objective was to induce BIM in road construction and for this purpose Primavera scheduling is explained above and will be compared step by step as the paper proceeds. Identification of the scheduling techniques are observed with the added features of the BIM platform for the reduction of cost and time, respectively.

2.1.1 METHODOLOGY (PRIMAVERA)

The procedure of developing primavera schedules is very simple and easy but requires considerable time as all data must be manually entered. Its main components will be explained in detail ahead.

2.1.2 STEPS REQUIRED IN CONTROL AND MONITORING: -

Given below are the steps which are to be followed when creating a Primavera based project.

- **Designing a Schedule:**

To start with, we should collect the data required for the specific project, or data obtained from the feasibility and survey reports.

- **Enterprise Project Structure (EPS):**

Enterprise structure is created for all the branches of the company which are involved in executing the project in Primavera P6. Each branch or node is further divided to its subbranches called its trainings.

- **Organizational Breakdown Structure (OBS):**

It is a hierarchal diagram of the management structure responsible for executing the project. OBS gives the authority of the personnel involved in the project from top to bottom. Each OBS is assigned a specific work in the work breakdown structure.

- **Creating New Projects:**

Each new project contains a group of activities that are associated with the respective EPS which in turn is assigned to a person in the OBS hierarchy. The projects start and finish dates are marked on a calendar which can also be a custom calendar specific for the project only.

- **Work Breakdown Structure (WBS):**

Main deliverables and objectives of the project which are to be followed in a sequence for the completion of any work, is given by WBS. WBS is also further dissected in activities elaborating more detail for a single WBS. Hierarchically every WBS node is equal to an EPS of any enterprise.

- **Explaining Activities:**

An activity is the smallest division of any WBS. They are the key constituent fragments of the project which are to be done from top to bottom or maybe simultaneously according to the WBS hierarchy. Project activity is denoted by a respective name and an ID.

- **Correlation of Activities:**

Line up of activities is correlated to create a grid of activities, which is settled by relating activities to each other as successor and predecessor. Further relations are given below.

I. Finish to start relation (FS)
II. Start to start relation (SS)
III. Finish to finish relation (FF)
IV. Start to finish relation (SF)

- **Activity Span:**

Proposed time span of any activity can be entered in the duration box. The original durations are obtained after an activity is completed and can be edited in the software.

- **Activity Fixtures:**

Different four types of dates are available in the P6, that are, actual and planned start dates, and actual and planned finish dates.

- **Activity Cost:**

The cost of individual activities all summed up to give the overall project cost that was consumed throughout the life cycle.

- **Creating Checkpoints:**

Checkpoints are created in the main timeline of the project against the schedule to track the performance of the project, and to keep up with the time available.

- **Gross Value:**

This technique is useful in comparing the proposed and built costs, gives company a figure of amount which was saved during the efficient performance of tasks.

- **Project Quality Check:**

Important criteria are assigned to each WBS for diagnosing issues evolving in the respective activities and project.

2.2 BUILDING INFORMATION MODELING

Building Information Modeling (BIM) is a creative innovation that has changed the way structures are seen, planned, fabricated, and worked. It essentially makes a virtual structure comprising of all the fundamental information.

It gives a physical and functional representation of a facility, not only this but BIM is an environment in its own. An environment where different dimensions (as specified by BIM) are integrated together.

BIM not only include geometry, but it also includes geographic information, light analysis, spatial relationships, quantities, and properties of building segments.

It is a platform that involves all qualities and frameworks on to a solitary virtual model. It permits partners and engineers alongside project workers to team up which demonstrates more productive and powerful when contrasted with the conventional techniques. This shows tremendous potential and has demonstrated valuable to diminish project costs by expanding its effectiveness.

Figure 2: BIM Dimensions

It essentially makes a 3D model that depicts real circumstances with an objective to have power over Architectural, Plumbing, Electrical, Mechanical, Structural, Scheduling models and Administration. It additionally empowers us to break down various perspectives on a model with reliable information consequently empowering the client to save more time.

People think that BIM is only up to 3D (depth, width, and height) modelling but it is more than that. It also covers 4D (time), 5D (cost), 6D (built operation), 7D (sustainability) and 8D (safety).

BIM mainly depends on the information part because in this part max data is to be provided from the user.

2.3 BIM APPLICATIONS

BIM systems for the construction and rehabilitation of the highways are trending recently and all the universities are taking full on measures to develop this new set of combined skills in alumni to come in future. Building information modeling platforms is a product of industry; a real time solution of design and calamities; but not a platform based on mere planning and hypothesis. Its applications are vast and expands to countless limits for every different project. It is to be consider that our infrastructure is deteriorating with the passing years and to remodel/reconstruct them, the BIM recreates and simulate the whole process layer by layer with respect to time optimization and shows what changes would bring significance in the environment, and the related risks; design, planning, and cost; are countered beforehand.

2.3.1 VISUALIZATION

To carry out a highway project, 2D models were used and subsequently testing laboratories were in effect which provides small scale models of the finished project on the respective topography. This is an error prone approach therefore, BIM visualization is now in demand and the complete integration of materials, design, and location of the project with its topography can be processed. This real time simulation provides accurate scheduling and budgeting which saves time. BIM visualization can guide the next possible mistake/problem in advance and therefore it is solved on the software itself before making the wrong attempt. Not only the design and planning phase is optimized but the construction process is also rendered in the software using its 4D technology. Based on this 4D method, traffic management can also be done on the same model for an efficient flow. Combining 3D and 4D dimensions BIM is now an active management technique for the engineers.

2.3.2 COST ESTIMATION

The availability of the BIM creates an opportunity to have a detailed examination on the fifth dimension (cost). This 5D based model is a simulation of future and therefore makes it easy to interpret the cost of the project while considering every chance and variant of changed plan/schedule or the material used. As BIM produces automated simulation of the takeoff, which helps in fast analysis. In addition to the project aided by BIM, there are special built-in tools for cost estimation, so we do not have to input manually everything, are structural components related to the design with added standard cost of each member/element which can also be altered according to present rates or different currency. Being an automated model, its cost is calculated based on materials which are taken from, as in our country, Pakistan standards. A software by Autodesk named Revit is used for the estimation of costs and is inherited with approximately all the construction materials used for any civil work.

2.3.3 CONSTRUCTION SEQUENCING

4D modelling is associated with the BIM model to simulate the sequencing of the construction as the project moves forward in real time in BIM platforms. The main benefit of the 4D feature is the optimization of the virtual plan, which is later rendered to be the perfect plan, by visualizing many possibilities. Although previously and presently people are still using 2D techniques to sequence the project but eventually it leads to incomplete or inconsistent delivery of the tasks. Therefore, it was impossible to precisely sequence the activities. Scheduling can be done by two main methods, 1) by utilizing built in tools, or 2) export the tools to platform and schedule from an outside source.

Integration of the schedules made on Primavera is imported to a BIM platform. BIM links the imported schedule to a predefined built-in construction model, and automatically provides a sequence. Using software with 4D tool capabilities such as, Autodesk Navisworks, which used to link model and the schedule.

- The Navisworks is capable to give visualized scheduling of the project which helps engineers and contractors to define their goals.
- A feasible plan is devised form the BIM tools which can be completed in an expected time.

- Being a real time schedule, it also updates with the on-site progress of the project and accounts for changes done on site.
- It also defines the mobility of the equipment used and hence its arrangement and availability to the site is efficiently made without delaying the main process.

2.3.4 CONFLICT/COLLISION DETECTION

Once a model is built in the BIM platform, we run it experimentally in real time visualization, several times to avoid any conflicts in the overall progress of the construction project. Design errors are also alarmed and solved before the commemoration of the project. Although many errors are countered in the designing and planning stage as the built-in tools are integrated based on some international standards, and if the software sense its violation, an indication is impulsively made. However, in case of highway project design, traffic simulations are also available which can be run to assess the serviceability of the virtually designed project. BIM, being an industrial product, also picks up the overlapping of the activities. It can automatically readjust an outcasted activity, but manual ways are too available.

2.3.5 FACILITIES MANAGEMENT

Work teams and resources are also managed by BIM. An enterprise's objectives are monitored in the platform. The information required for each department is made accessible to the personnel, so that they can manage the utilities and resources of the company. Outcomes can also be improved by integrating BIM on smart decision making related to activities. Hence, complex managements in complex projects are correlated with feasible resources for takeoff.

2.3.6 CODE REVIEWS

Management of emergency protocols for the highways are assessed in the planning phases, and for an existing infrastructure, a model is built, and real time simulation of accidents, calamities, natural disasters, or disaster encountered by structural fault are processed, and their instant solutions deduced by experts are handed over to the concern departments which are to act promptly in case of an emergency. Multiple evacuation routes are also specified for medical and fire departments, to ensure the complete safety of the people. Therefore, disaster management for any civil project can be studied and the improvements in safety can be made accordingly.

2.4 BENEFITS OF BIM

BIM is yet being developed and has given a ton to the Architecture, Engineering and Construction (AEC) industry. Even though it is yet during the time spent being embraced by the business there is still much more to go.

Table 1: BIM Benefits During Different Phases

Stage	**Advantages**
Planning	○ Easy and quick analysis of alternate methodologies. ○ Helps in energy analysis after 3D modeling. ○ Early quantity take-off calculations and cost estimates. ○ Helps in development of technical and non-technical specifications.
Design	○ Improved Co-ordination between architects and engineers. ○ Easy exchange of information. ○ Auto clash detection to solve upcoming problems.
Construction	○ Reduction of Problems pertaining to the interpretation of plans. ○ Effective coordination between stakeholders. ○ Reduction in construction problems ○ Helps in maintaining the schedule
Operation and Maintenance	○ Easy and effective access to maintain records, manuals, warranties, etc. ○ Resolves space management issues. ○ Aids emergency evacuation planning.

One study found almost three quarter of organizations using BIM have profited considerably with the most valuable of them all being the time value that if equated to money has amazingly shocking monetary benefits.

The Companies who use BIM can see the accompanying upgrades in their firms.

A study of a minor contracting firm revealed that usage of BIM increased labor productivity almost 3 times for prefabricated and modeled areas.

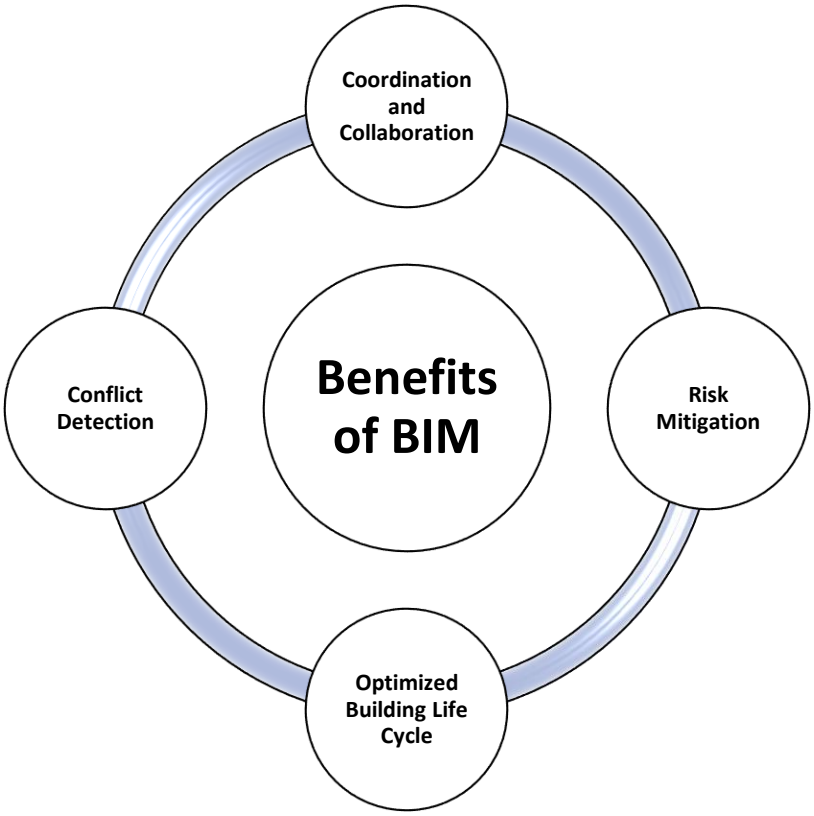


Figure 3: Benefits of BIM

Using BIM in the construction sector helped to achieve great productivity speed, high quality work, & low cost for building professionals in terms of construction, design, and operation of project. It provides:

- High Quality: BIM provides an ultimate quality of product that could never have been imagined in the previous design or execution phase.
- Better Speed: Usually the biggest advantage of BIM is its fast speed which has plenty of economic value and a great head-start for every project.
- Low Cost: BIM can help avoid all sort of costs, may they be related to monetary or non-monetary costs like by saving time or labor etc.

2.5 BIM IN THE AEC INDUSTRY

In a distribution by (Construction, 2008) two studies were led to set up a report available dependent on BIM's utilization in the AEC business. The study was attempted by 100 specialists, 83 planners, 79 workers for hire, and 41 proprietors making a sum of 302 individuals in the United States. The aftereffects of the review were:

- Architects' heaviest clients with 44% of them utilizing it in over 61% of their activities though workers for hire were lightest clients with 46% of them utilizing it in under 16 % tasks.
- 83 % chances are that the BIM helpfully affected their organization by improving usefulness.
- 78% of BIM clients that BIM improved results of the venture and brought about less Request for Information (RFI).
- Increased odds of BIM to win the task are accepted to 65%.

2.6 BIM TOOLS

A study drove by Samara and Burcin in 2010 among 425 development firms in the USA showed that Autodesk BIM apparatuses are mostly utilized taking up 54% of all out clients. GRAPHISOFT ArchiCAD was on second at 10.7% and Bentley BIM is at 8%. Tekla and Vico are at 6.5% and 5.8% separately. Other programming like Dprofiler, Vectorworks, Innovaya, and so forth are yet being utilized yet at a lower scale. However, the buy and utilization of programming rely on devices and capacities and impediments of every product and necessities of the firm.

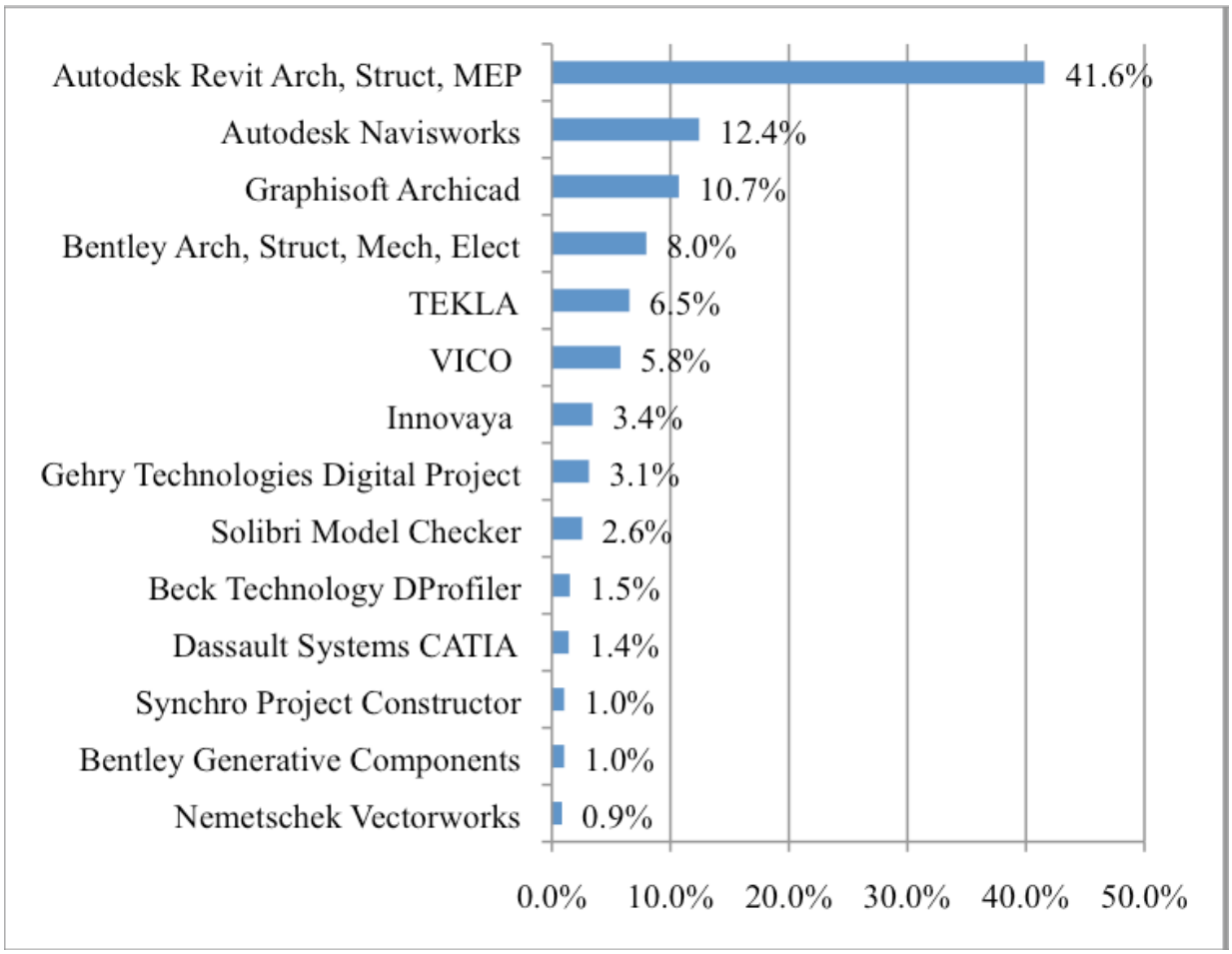


Figure 4: Utilization of BIM tools

BIM is adopted worldwide by all major firms as it is one of the most advanced technology in the industry. Even the software developers are focusing their efforts into products related directly or indirectly to different BIM areas. Different functionalities are being covered in these areas that pertain to the Building Information Modelling (BIM) model that enable the user to choose the software as per their needs the following is a concise detail on different BIM tools accessible in market with their essential employments. Even though the fresher adaptations accompany a bunch of instruments that builds their space of usefulness. Some of the software that are accessible are briefly introduced in the table below:

Table 2: Different BIM Software and their Uses

Company	**Software**	**Major Usage**
Autodesk	Revit	BIM modeling
	Navisworks	Clash Detection, Quantity takeoffs, 4D Scheduling
	Robot Structural Analysis	Structural Analysis
	Green Building Studio	Energy Analysis
Graphisoft	ArchiCAD	BIM Modeling
	Estimator	Estimation
	EcoDesigner	Energy Analysis
Bentley	AECOsim	BIM Modeling
	Project Wise Navigator	Review and analysis
Tekla	Tekla Structures	Structural Modeling
	Tekla BIMsight	Analysis and review
Vico	Vico Control	4D scheduling
	Takeoff Manager	Quantity Takeoffs
Company	**Software**	**Major Usage**
Synchro	Synchro Professional	4D Scheduling
Innovaya	Visual 4D Simulation	4D Scheduling
	Visual Estimating	Estimation
	Visual Quantity Takeoff	Quantity Takeoffs
U.S Cost	Success Estimator	Estimation
On Center	On Center	Quantity Takeoffs

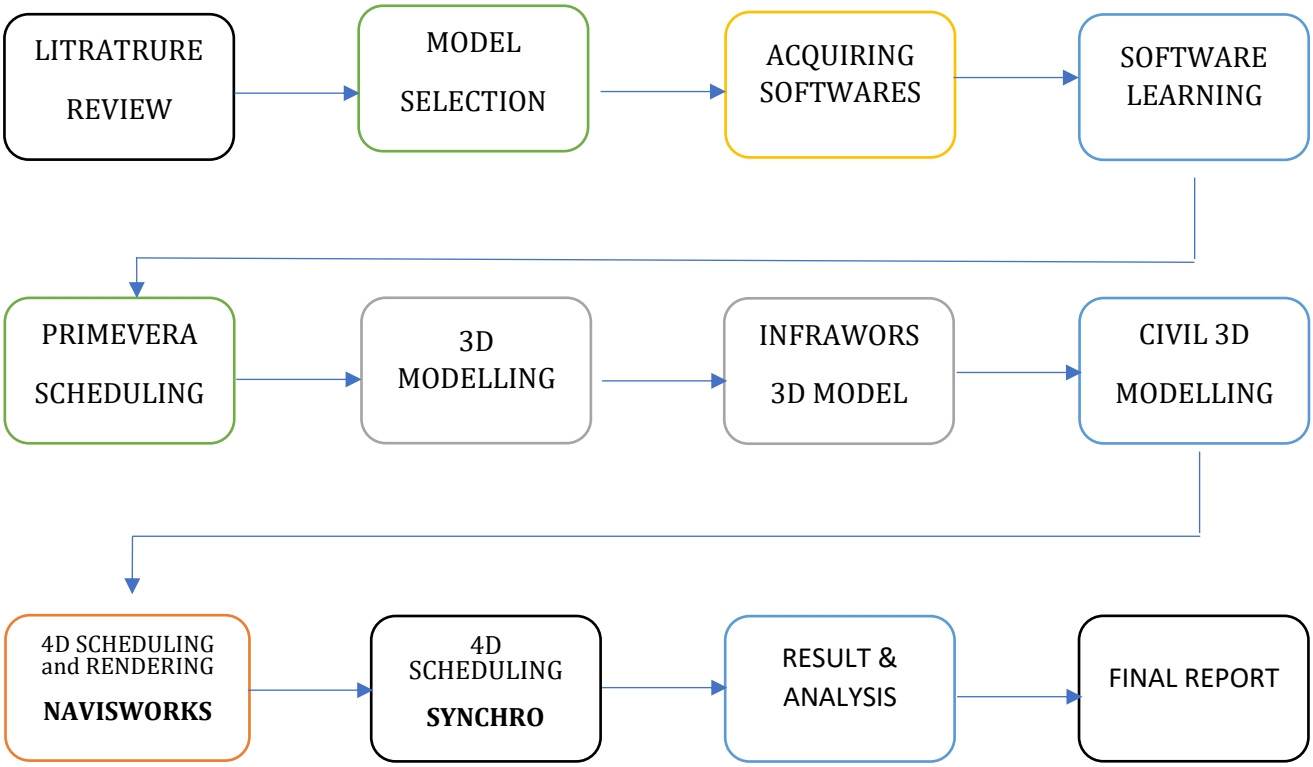
SUMMARY:

- Primavera is a very powerful platform for scheduling and has been used worldwide for all sorts of projects.
- BIM is an environment where different software are integrated and hence it has a wide range of applications.
- Integration of BIM and Primavera can lead to ground-breaking results.

CHAPTER 3: METHODOLOGY

3.1 GENERAL OVERVIEW

The following methodology shown in flow chart will be observed while completing. Research project.



3.2 SOFTWARE SELECTION

The process of software selection is major component of research project as it impacts upon the outcomes of the project.

An extensive research was carried on internet to select appropriate software for each individual task to be carried throughout the project. After gaining in depth knowledge of their features and functionality software's were selected.

The selected software's are as following:

- Autodesk Infraworks
- Autodesk AutoCAD civil 3D
- Bentley Synchro
- Autodesk Navisworks

Afterwards trial version (student version) of following software's were downloaded and installed.

3.3 CASE STUDY

The highway selected for 3D modelling in Autodesk AutoCAD Civil 3D and 4D Scheduling in Autodesk Navisworks and Bentley Synchro is Lahore Ring Road Southern Loop-I.SL-I (9.35 km): Starts from Sui Gas Town¿ and finishes at Ferozepur Road. The arrangement goes through Kamahan town, crosses the Hadiara channel and finishes at interchange to be developed at GajjuMattah on Ferozepur Road.

Figure 5: Lahore Ring Road (Area of Case Study)

3.4 3D MODELING

Building Information Modeling (BIM) is a 3D modelling process that provides Engineering and construction professionals and architecture tolls and ideas to more efficient planning, design construct and mange construction buildings and infrastructure.
The modelling of southern Loop-1 of Lahore Ring Road is done in Infraworks then Infraworks model is imported in civil 3d as an .imx file.
Planning highways only import Alignments in civil 3D while designing highway imports components of road, alignments, and profiles.
Aerials, Buildings, City Furniture, 3D Solids/Models, etc. are not imported to Civil 3D from InfraWorks.

3.4.1 PREPARE INFRAWORKS DATA FOR USE IN CIVIL 3D

This project was created using Model Builder:

a. Go to model builder.
b. Enter aerial mode from the top right of the dialog to display an aerial view or switch to road for the road view.
c. Select desired location.
d. Chose Required Area(0-200km)
   - Select current map.
   - Draw required shape area using rectangle or polygon selection tool whichever suits best.
   - Import selected area.

e. Exporting an IMX:

"Settings and Utilities> Export IMX> Define Interactively [blue boundary] or Use Entire Model> Target Coordinate System > Set Destination Folder Exported file …SL-1 Data\InfraWorks Model\IW_Export.imx"

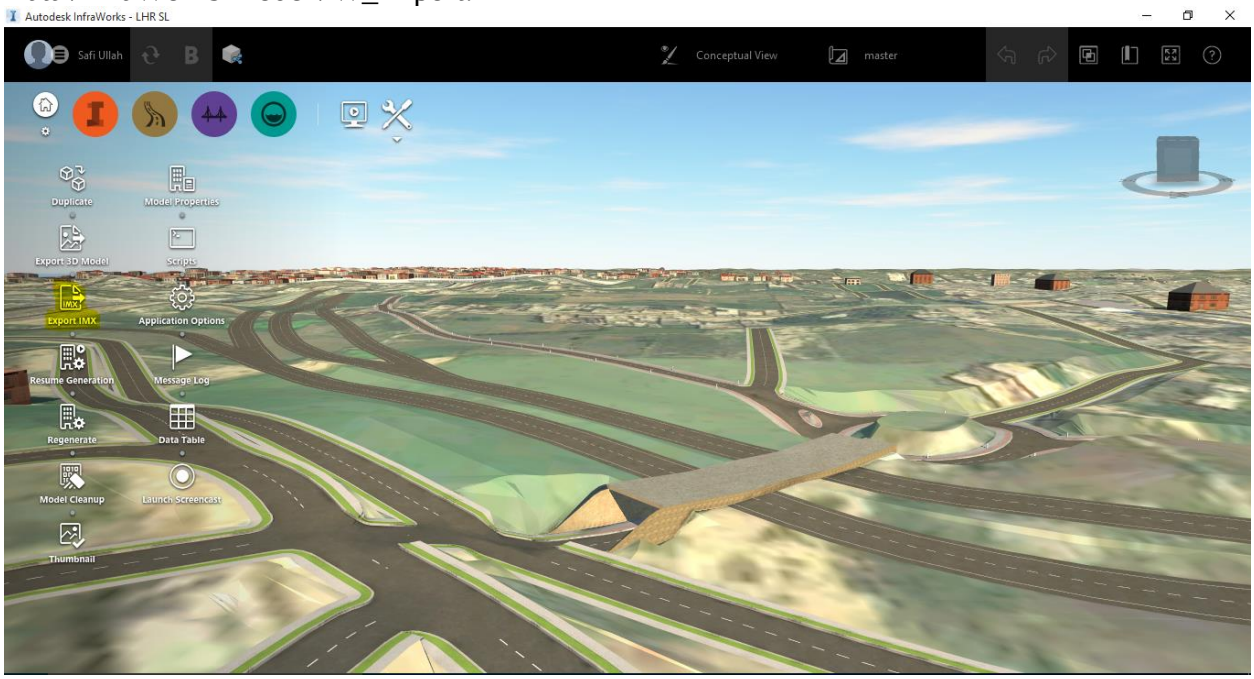


Figure 6:Lahore Ring Road's InfraWorks Model

3.4.2 IMPORTING INFRAWORKS DATA TO CIVIL 3D

a. Data must be imported to real world coordinates/location.
b. Change the Coordinate System using: MAPCSASSIGN or via Drawing settings
c. Use SL-1 Data\Civil 3D Files\Civil1.dwg
d. Import InfraWorks IMX/SQLite data using the Autodesk InfraWorks Ribbon tab in Civil 3D.
e. Exchange Settings breaks down all that imports from InfraWorks:

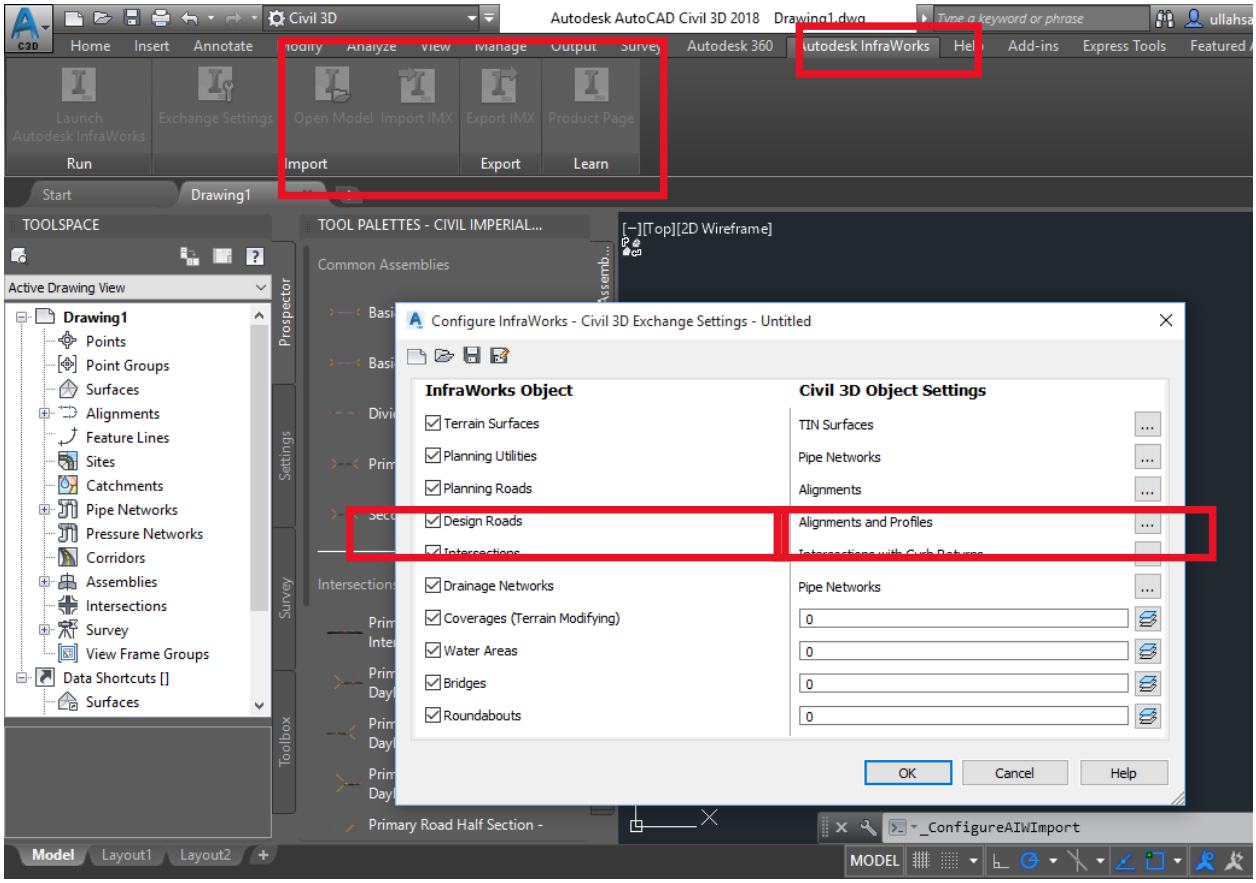


Figure 7: Importing InfraWorks Data to Civil 3D

3.4.3 IMPORTING IMX IN CIVIL 3D

a. Import IMX SL-1 Data\InfraWorks Model\IW_Export.imx]
b. Typically, 3 Surfaces import from infraworks, and are Grid type surfaces: smooth Contours but rough boundaries
   - AIW_Existing_Ground
   - AIW_Existing_Transportation
   - AIW_Proposed_Ground
c. Imported roads are assigned a default proposed style.
d. As noted above: Planning [sketch] Roads will not have an assigned profile.
e. Imported Coverages will import a 3D Polyline representing the boundary.
f. Bridges created in InfraWorks will import as a 3D Solid.

g. Pipes and Structures will import as Pipe Networks.

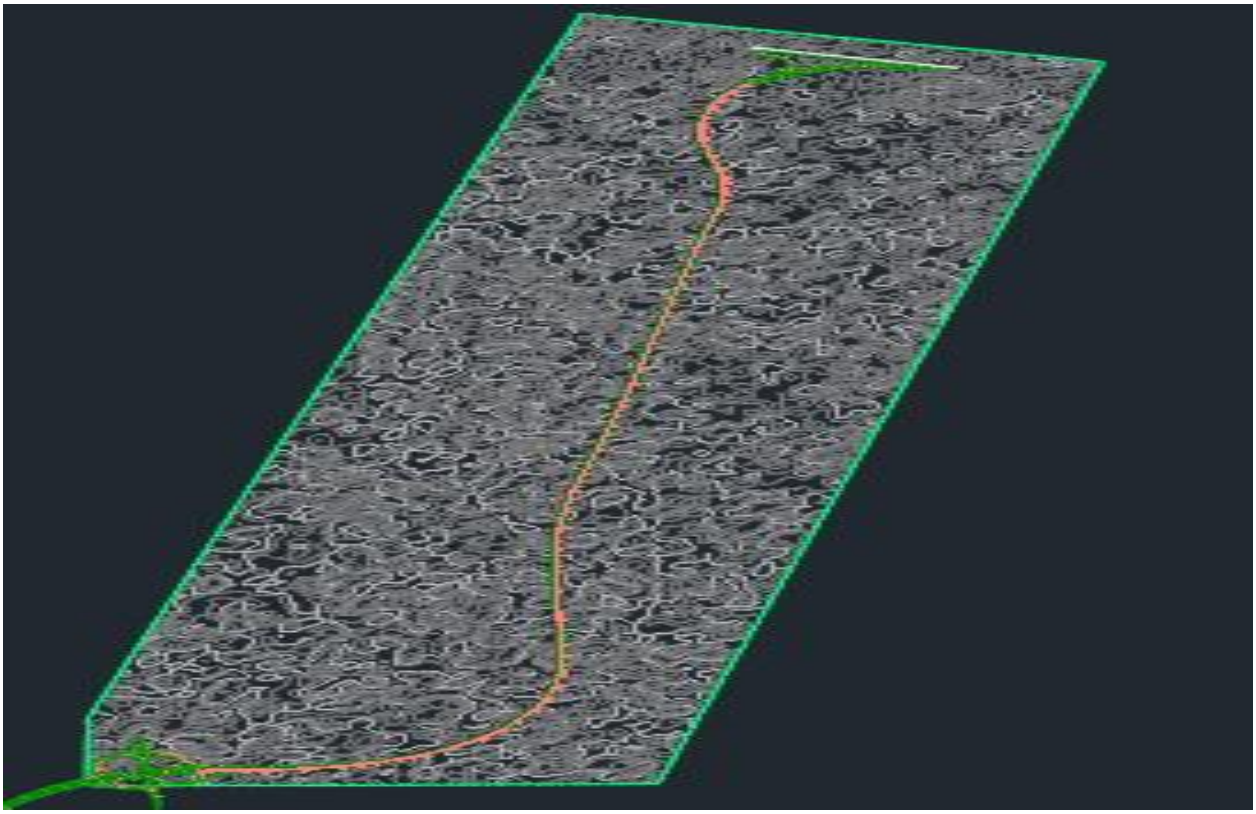


Figure 8:Refined model Lahore Ring Road

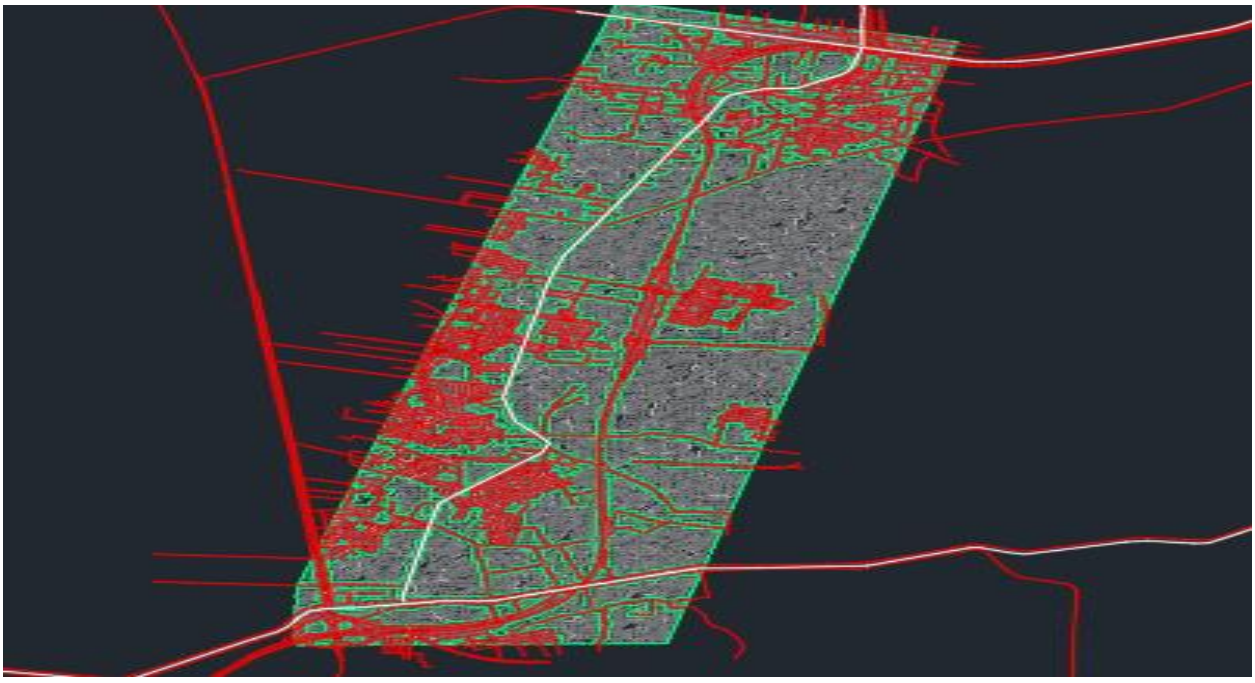


Figure 9: Unrefined InfraWorks Model Import in Civil 3D

Figure 10: Alignment of Lahore Ring Road Southern Loop (SL-1) in Civil 3D

3.4.4 MAKING ROAD ASSEMBLY IN CIVIL 3D

The Highway assembly shown below represents the right of way of Southern Loop I of Lahore Ring Road. The typical cross section drawing was obtained from permitting agency. Using civil 3D same features of a roadway can be achieved. We have recreated, the typical cross-section requirement of **Southern Loop 1 of Lahore Ring Road**.

- Width of Lane =**10.95m or 34ft** on either side centerline
- Slope = 2%.
- Then, a Treated Shoulder **3m** or **9.6ft**, at a **4%** slope.
- Finally, a **0.5m** or **6ft** Rounding at **4%** slope.

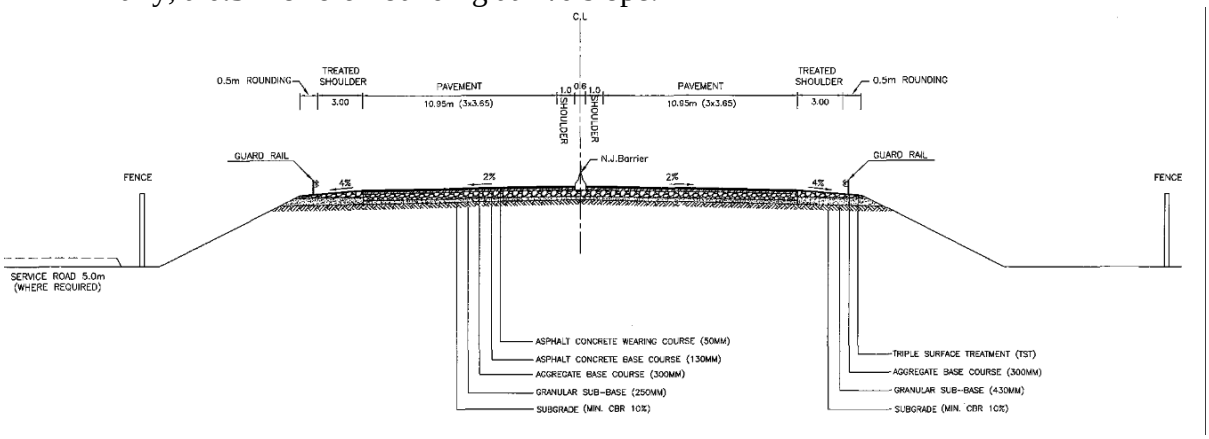


Figure 11:Drawing of a Typical Cross Sectional of Lahore Ring Road

.

Corridor building has few pre-requisites like creation of assembly and drawing cross sections as shown below:

Open the **SL-I dwg** file created from imx file imported from Infraworks.

- Use Create Assembly under assembly.
- Then name the assembly SL-1 according to location where assembly must be laid. Further details are to be enlisted, some being optional.
  - First give any description for assembly
  - Then select the type of road. Choose 6 lane divided highway separated with a barrier.
  - Afterwards select assembly style to basic and Code set style to all codes.

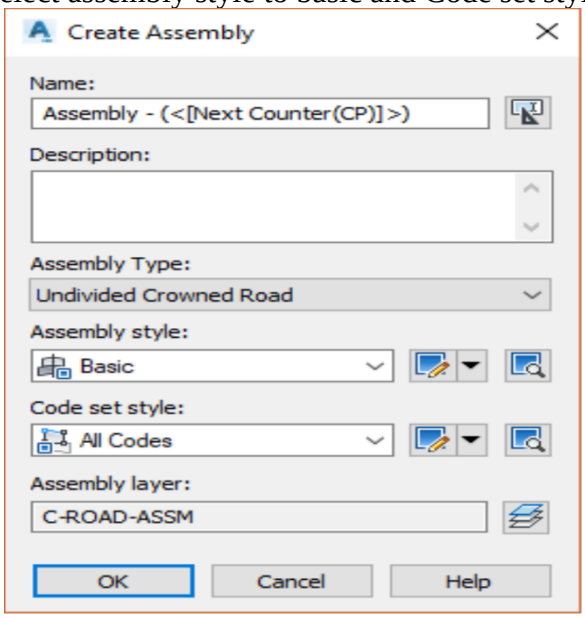


Figure 12: Civil 3D Assembly Creation

  - Select where to insert alignment.
- Next, we must formulate its elements named as sub-assemblies where we can add all sort of features like lanes, shoulders, curbs, gutters, median etc.
- Now we can easily formulate our required cross- section.

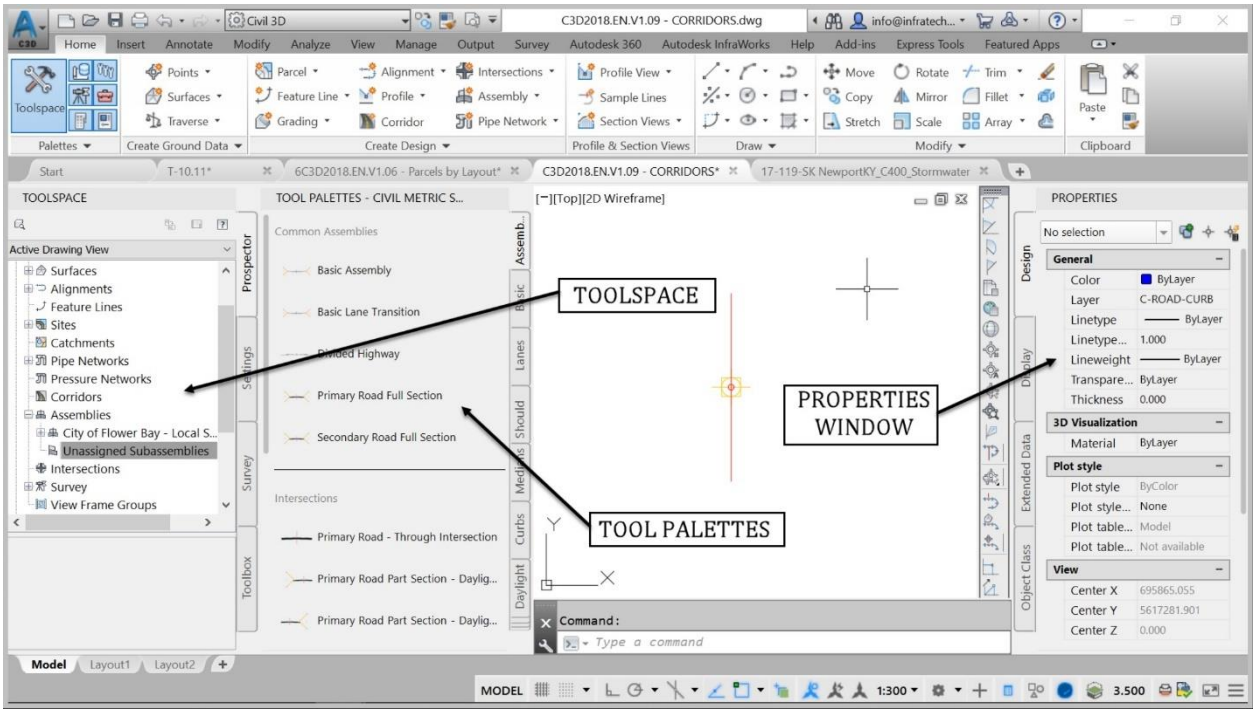
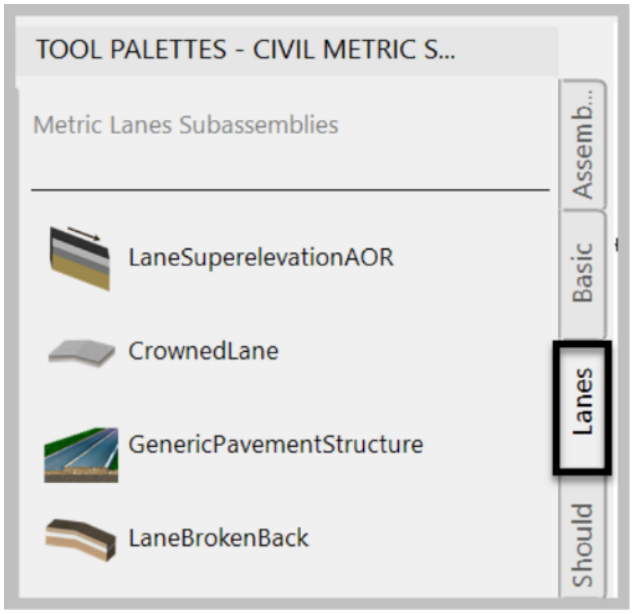
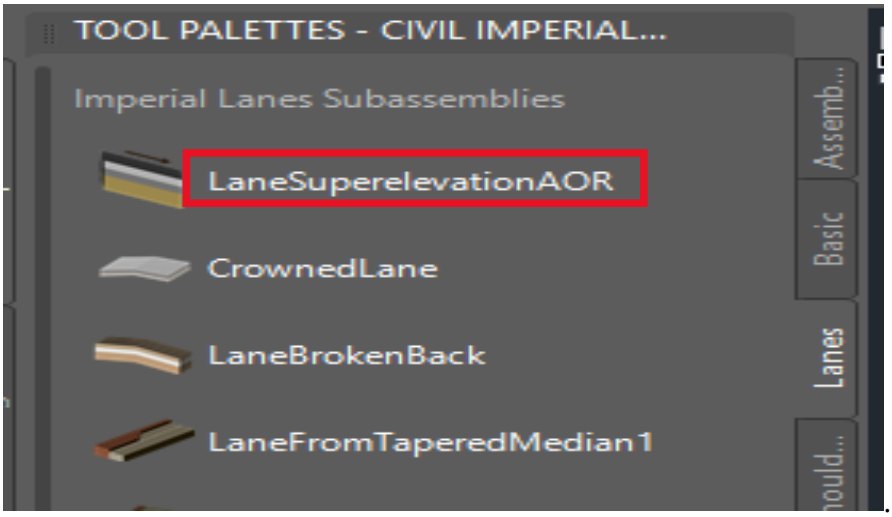


Figure 13: Civil 3D User Interface

- We start making from centerline and can then proceed in either direction.



- From our drawings we chose the following items to have a best representation



- We chose all layers and other specifications as per specifications in the drawing shown above.

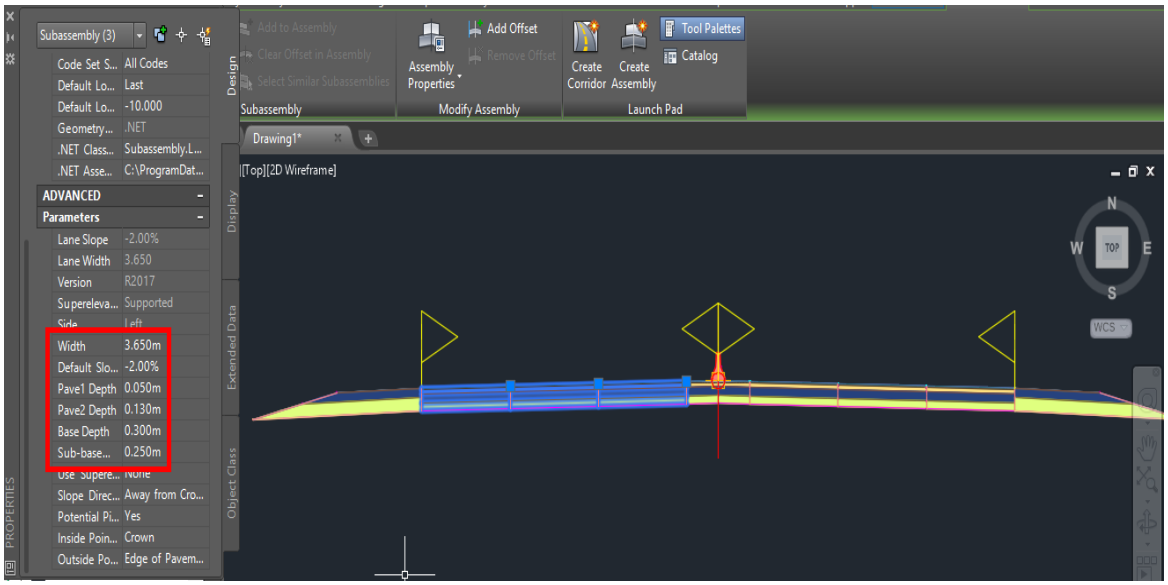


Figure 14: Pavement Main Carriageway Layer Specifications in Civil 3D

- ACWC 50mm = Pave 1 depth
- ACBC 130mm = Pave 2 depth
- Agg Base Course 300 mm = base depth
- Gran Subbase 250mm = sub-base depth
- 6 lane divided highway separated with a barrier.

- We can make one complete side like this and then mirror it on the other side.

Adding Barrier:
Similarly, New Jersey Barrier can be added by selecting a simple barrier under basic tab. In the drawing, click the marker point at the outside edge of the sidewalk subassembly.

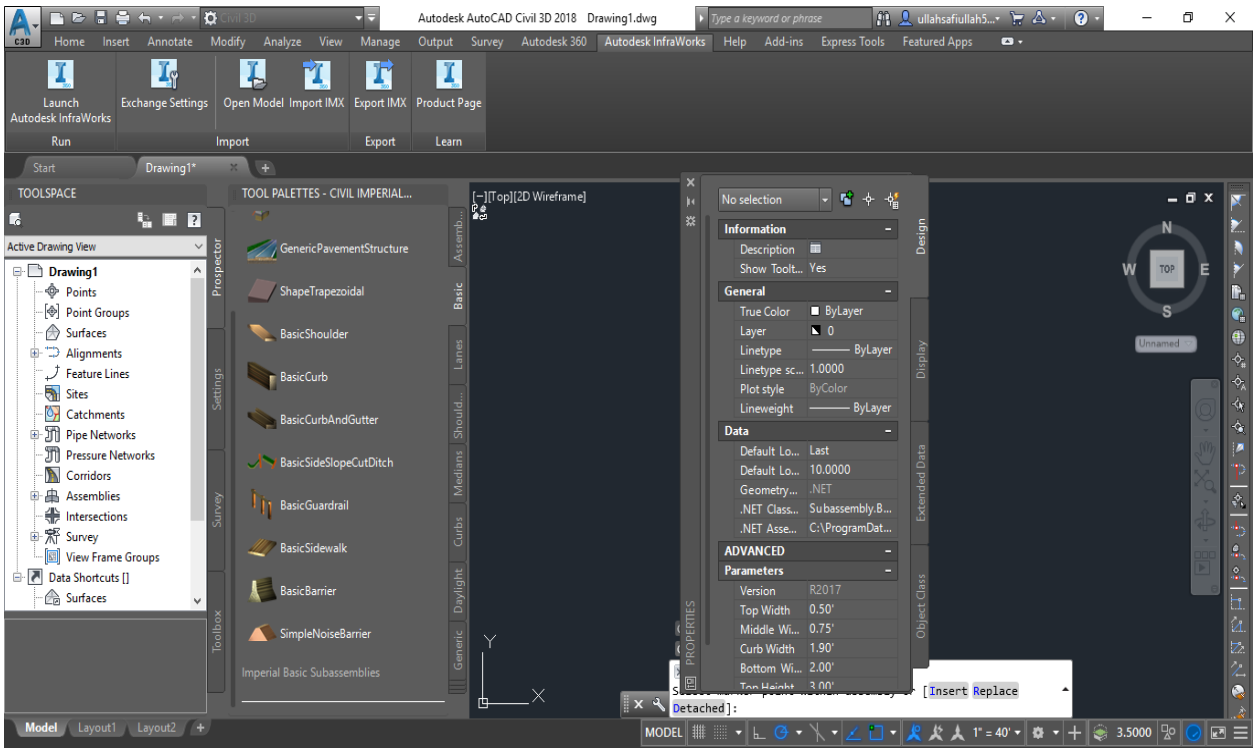


Figure 15: Adding Barrier in Civil 3D

Adding Shoulders

Similarly, all sorts of Shoulders are available from which we can select the one that is best representation as per drawings.

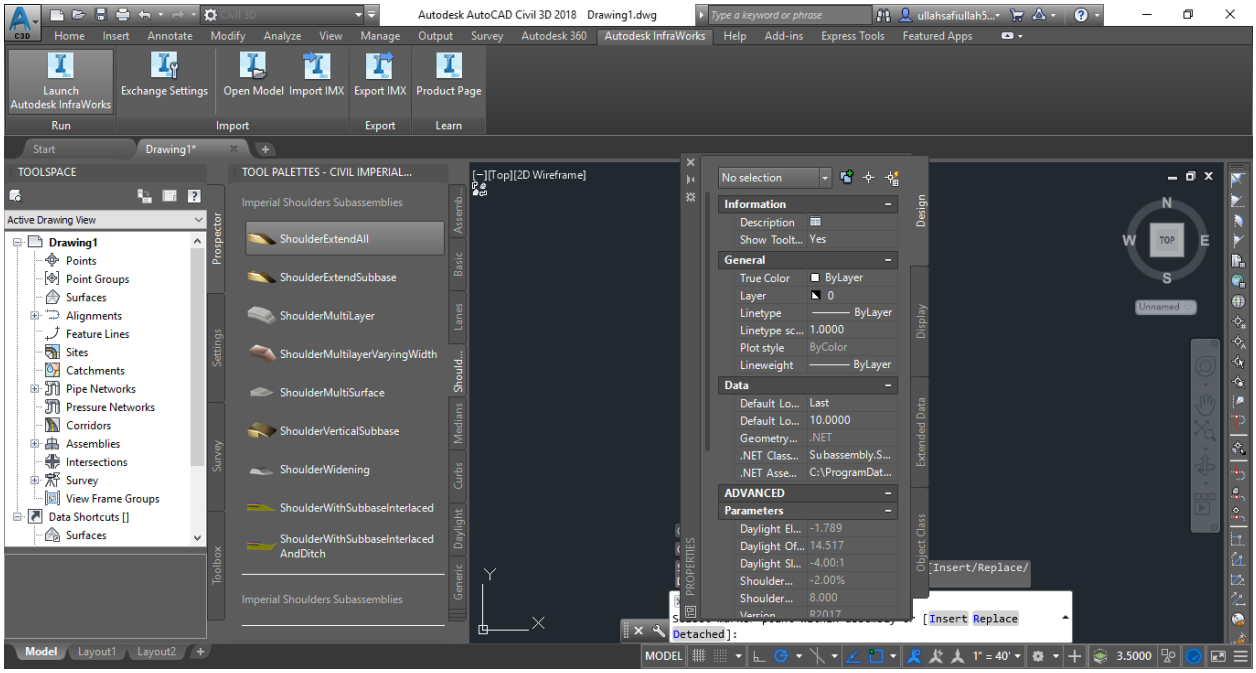


Figure 16: Adding Shoulder in Civil 3D

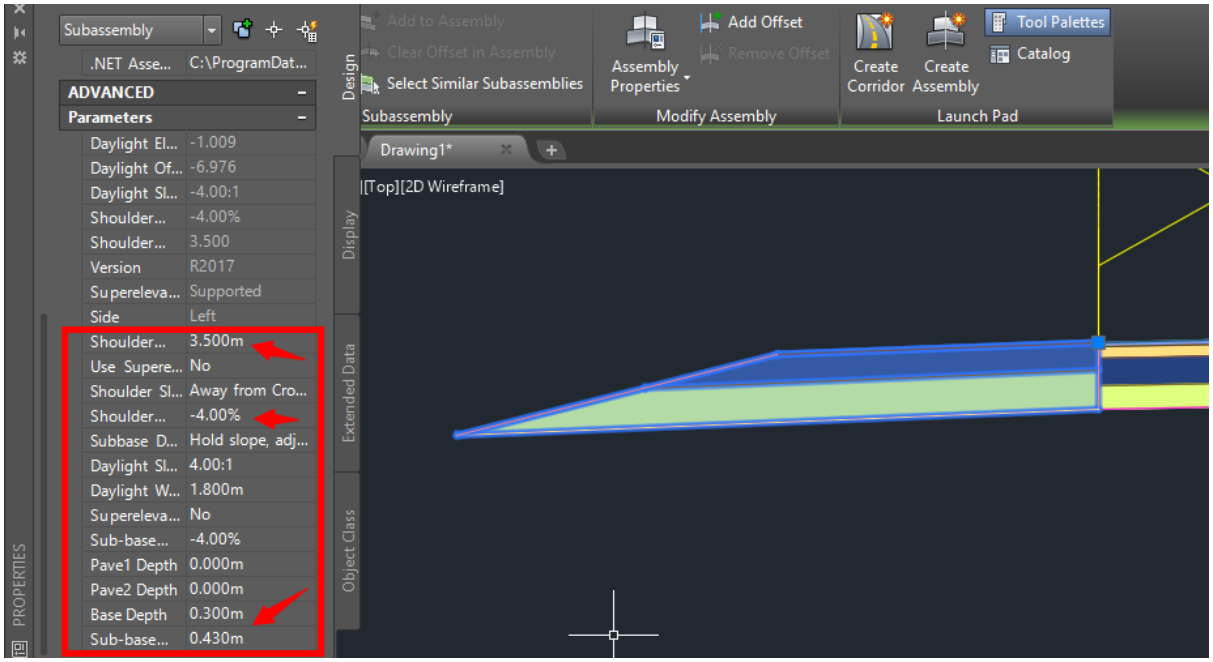


Figure 17: Shoulder Specifications in Civil 3D

Add a Daylight Sub-Assembly:

In a similar way we can add daylight which is basically used to formulate the cut and fill along the drawn section.

It has very major importance as it is dynamically linked with longitudinal profile of our alignment and any change in it will in return change our cut and fill parameters.

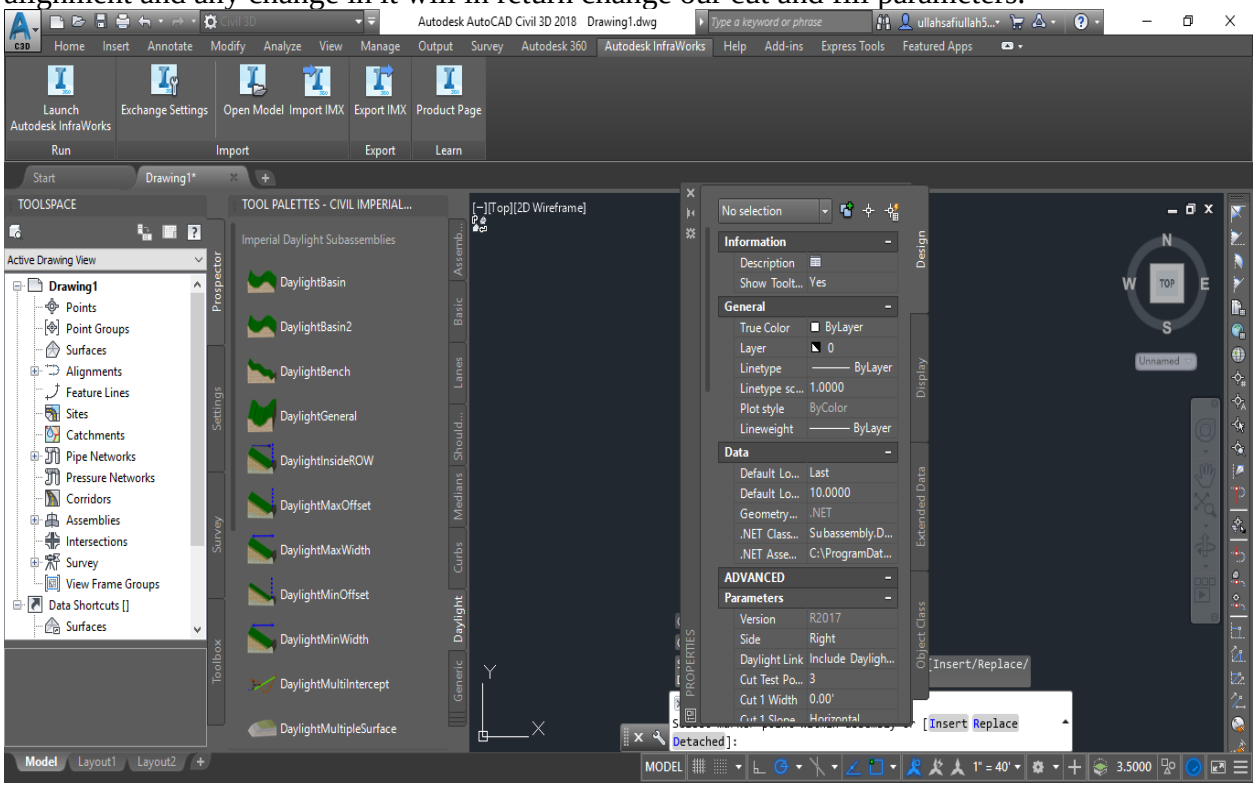


Figure 18: Adding Daylight in Civil 3D

Next, we must link our road to a surface so that it has something till which it can relate for calculations like cut and fill volumes etc.

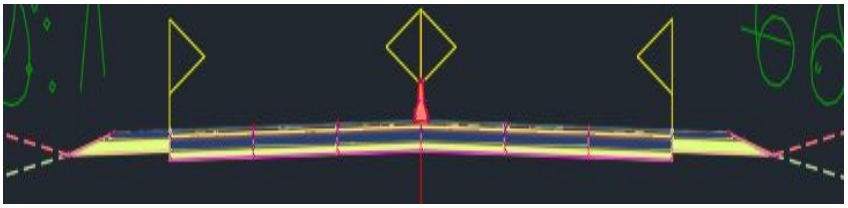


Figure 19: Assembly Created in Civil 3D

Add Corridor

a. Corridor can be added very easily once all previous steps are perfectly executed.
b. The aim should be to minimize error at initial stages as little measurement flaws can result in enormous mistakes when it comes to cost calculations specially.
    - It also has similar interface with different properties each describing a specific corridor.
    - We must be very clear what all can be related to our required roadway.
c. Then we can assign the alignment created with our assembly we just created in the previous step to form a corridor.

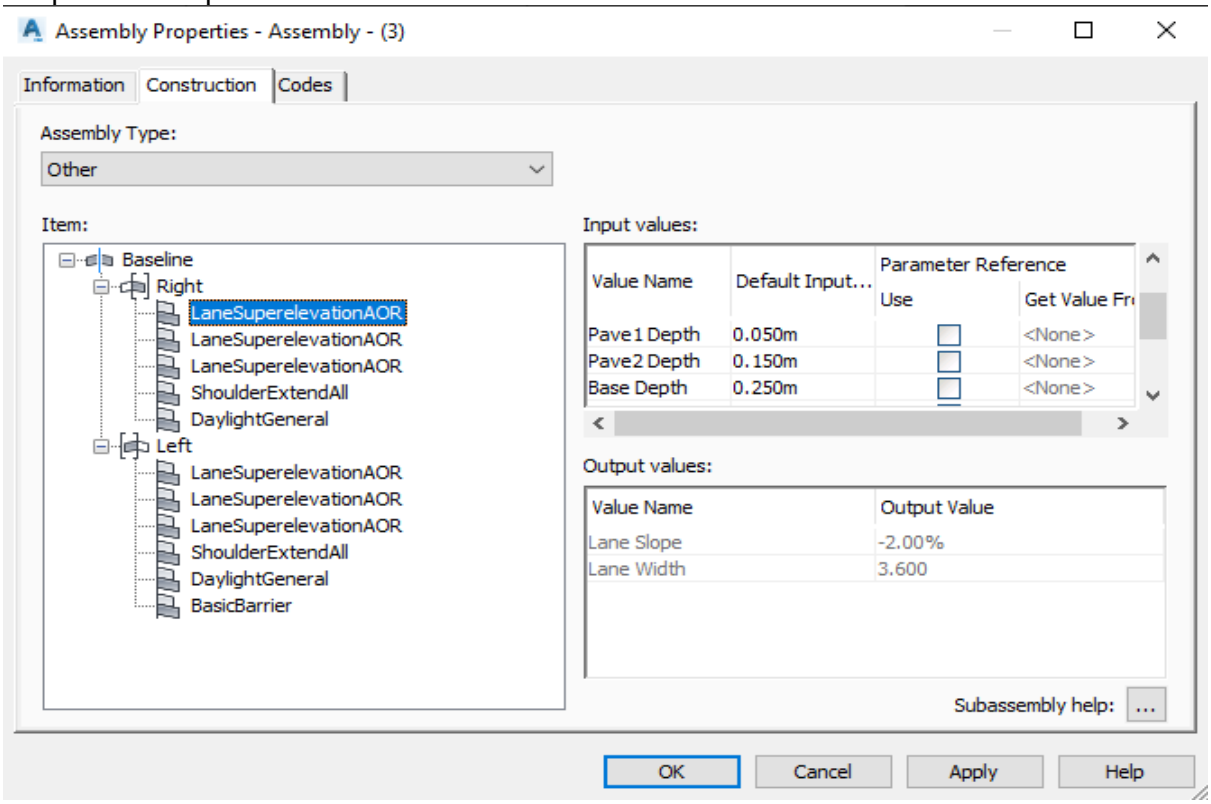


Figure 20: Assembly Properties

Pave 1= Asphalt Wearing Course

Pave 2= Asphalt Base course

Base=Water Bound Macadam

Sub-base=Granular sub-base

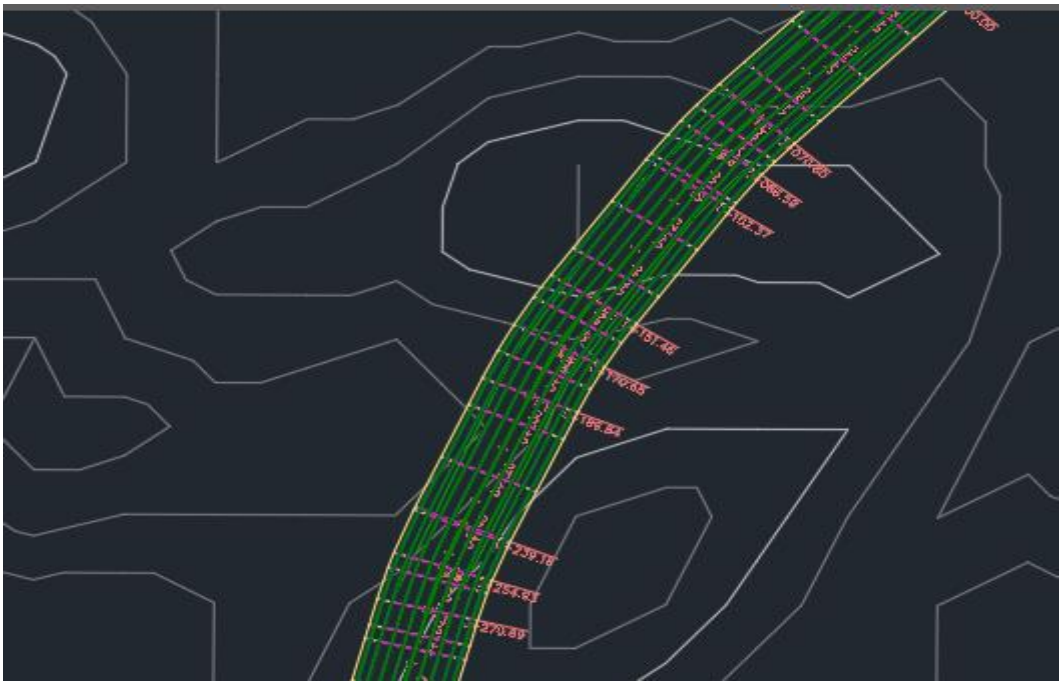


Figure 21: Corridor Building in Civil 3D

Extracting Corridor from Solids

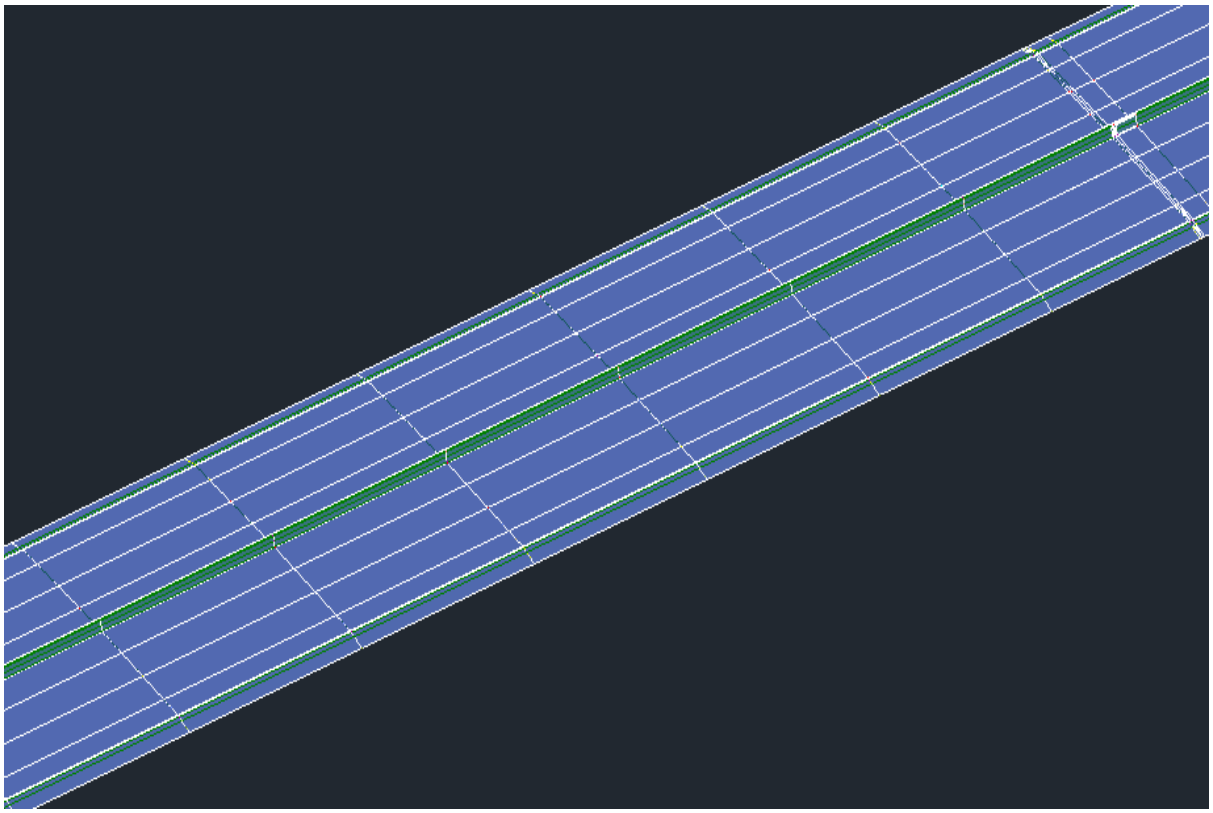


Figure 22: Corridor Extracted from Solids

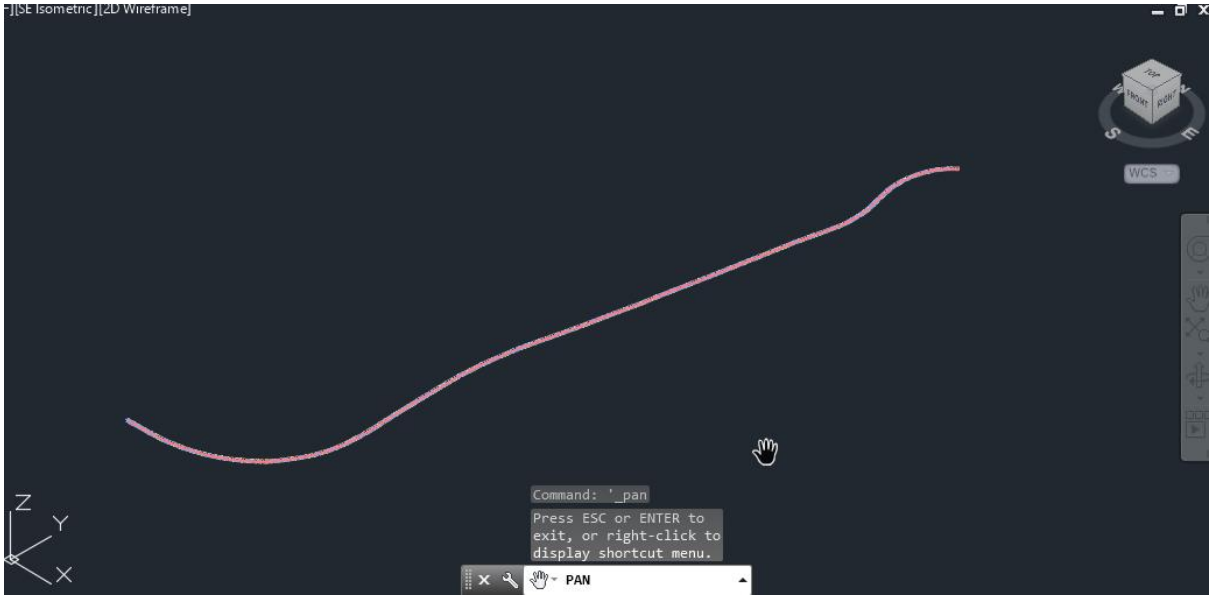


Figure 23 Southern Loop (Lahore Ring Road) Modelled in Civil 3D

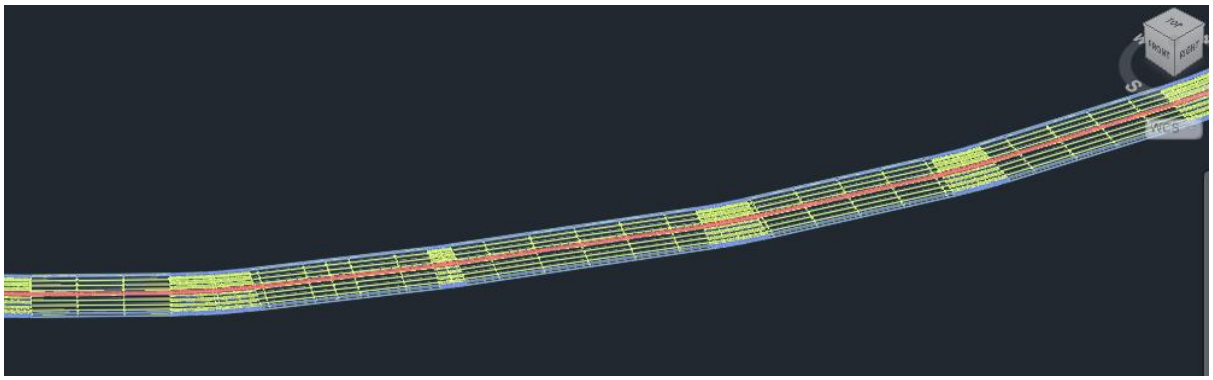


Figure 24: Conceptual View of Civil 3D Model

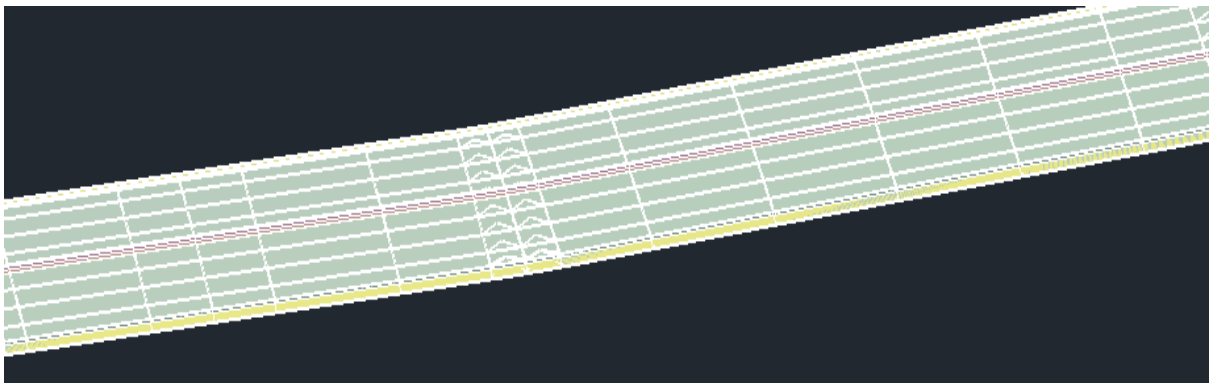


Figure 25: Realistic (Un-rendered) View of Civil 3D Model

3.4.5 EXPORTING CIVIL 3D DRAWING TO NAVISWORKS

a. Open the Civil 3D drawing.
b. Go to Output tab, Export Civil 3D drawings and Export.
c. Open the exported dwg file in Navisworks.

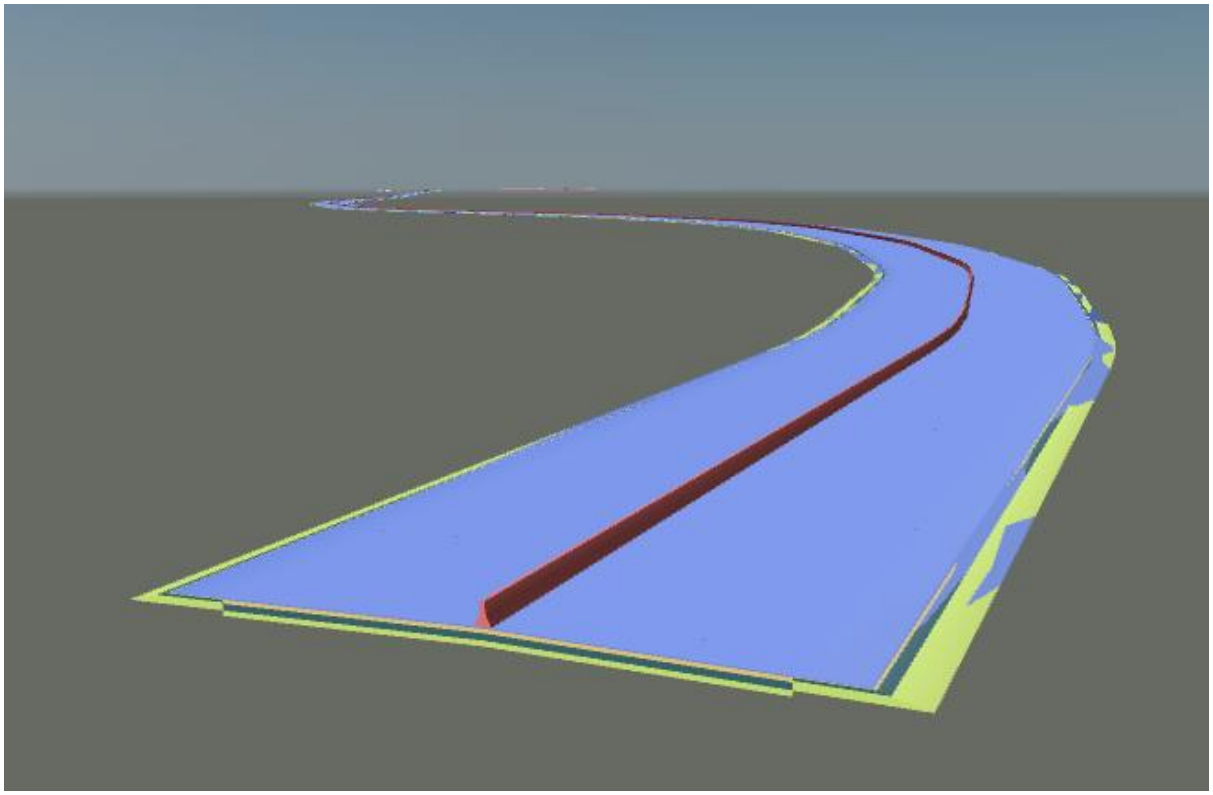


Figure 26: Conceptual View in NavisWorks

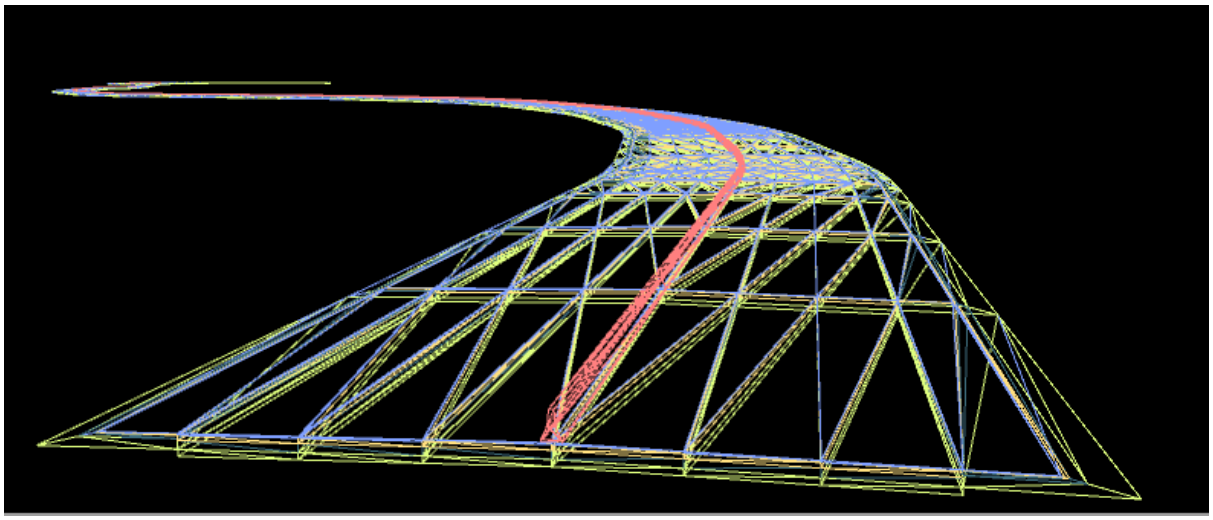


Figure 27: Wireframe View in NavisWorks

3.4.5 RENDERING IN AUTODESK NAVISWORKS

a. Navisworks does not have a very detail rendering option specially when it comes to roadway projects.

b. However, the option of rendering along with 4D simulation creation power is a strong feature which is usually not found in other simulation software like Bentley Synchro.

c. Navisworks itself has a very user-friendly interface specially for creating a schedule and similarly for rendering.

d. Basic elements like concrete, asphalt etc. are already predefined and can be assigned to objects of any model for rendering purpose each with several varieties of corrections related to texture brightness etc.

e. Even we can create our own material properties if needed.

f. Following are screenshots of our project rendered in Navisworks.

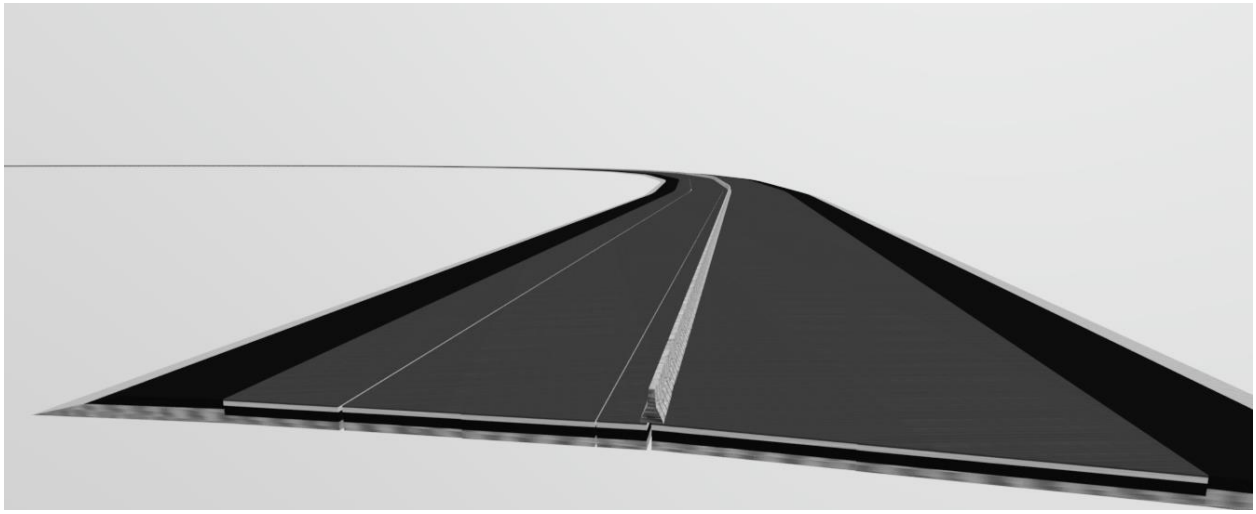


Figure 28: Rendered Model in NavisWorks

3.4.6 4D SCHEDULING NAVISWORKS

1. Scheduling of Navisworks is not as powerful as Primavera but it is much easier and user friendly.
2. It takes less time with many shortcut commands which improves work efficiency etc.
3. However, there is a lack of few options that make primavera better than it only for scheduling like we cannot develop relationship between activities like FS, SS, FS and SF.

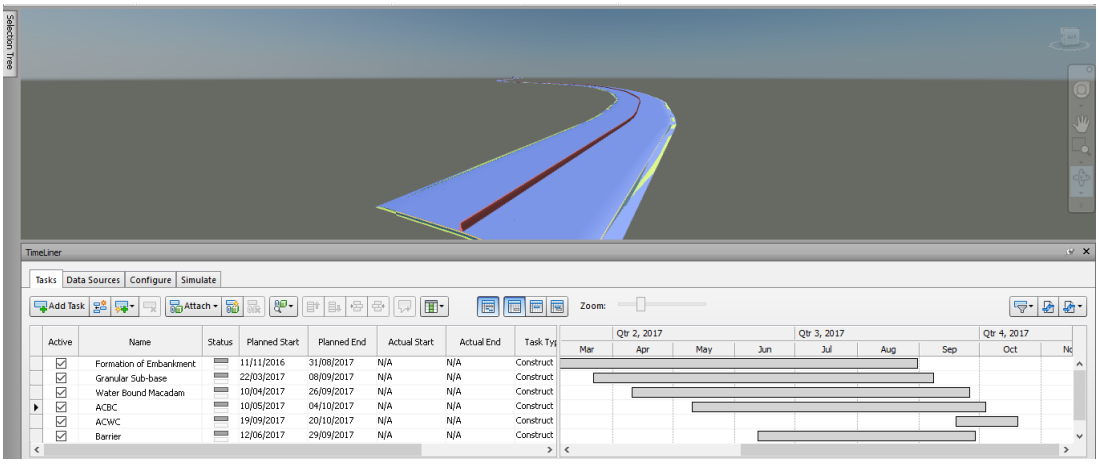


Figure 29: 4D Scheduling in NavisWorks

3.4.7 4D SCHEDULING SYNCHRO

- Synchro is a much simple and convenient software.
- It has the linking ability to assign relationships to activities as well, one thing that is a major missing in Navisworks.
- It does not have the rendering or other additional features, but this also has a plus side that it results in it being of very less size compared to Navisworks.
- It has a powerful import feature, especially for our case which was necessary as our scheduling had been done on primavera, so this software was best fit for our purpose.

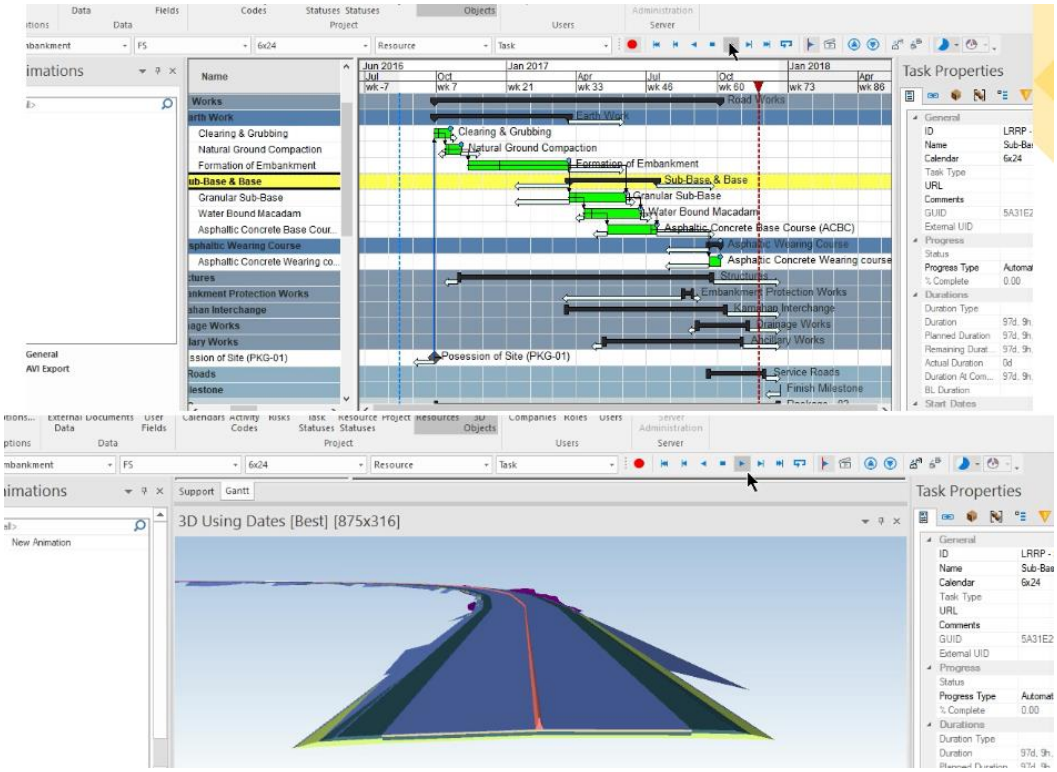


Figure 30: 4D Scheduling in Synchro

SUMMARY:

- There is wide range of software available in the market for modeling, planning scheduling and even further.
- Selection of the software best suited for your project is the most important factor which can improve time efficiency significantly.

CHAPTER 4: RESULTS AND ANALYSIS

OVERVIEW:

- Results and their analysis obtained from different software of our project with references to attached annexures at the end showing the product.

4.1 RESULTS

The results are based on the products that have been extracted by using different software. The basic aim is to describe BIM, and how different software were integrated. AutoCAD Infraworks, Autodesk AutoCAD Civil 3D, Bentley Synchro and Autodesk Navisworks were used as main software and primavera was used as supplementary software. The comparative study was done regarding Lahore Ring Road Project (SL-1). The results thus obtained using the below methodologies are attached as annexures. From planning to 4D simulation, different software were used with following results.

4.1.1 PRIMAVERA

In primavera, each aspect from setting up and defining EPS to scheduling was already done. The following results were extracted from primavera:

- EPS and OBS
- WBS
- Activity report
- Gantt Chart
- Claim Report

Results displayed in Annex-A.

4.1.2 AUTOCAD INFRAWORKS

The Modular of Lahore Ring Road (SL-1) was extracted by using AutoCAD Infra Works, it also employed the use of BING Maps, the GIS database available gave us the required survey points, as a result we exported the model to AutoCAD Civil 3D. we use.

Results displayed in Annex-B.

4.1.3 AUTOCAD CIVIL 3D

The module extracted from AutoCAD Infra Works was exported to AutoCAD Civil 3D as we did not have a geo-survey available of that region. We then segregated our point of concern (SL-1). The alignment and the Road Sections were marked using 2-D plans available to us. We then gave the input regarding the various layers (sub-base, granular base etc.). The six-lane highway was then separated with a barrier. Corridor assembly was further defined. The product obtained was then ready to be exported to Navisworks as a model. The model obtained was 3-D in nature**.**

Results displayed in Annex-C.

4.1.4 AUTODESK NAVISWORKS

The entirety of the data was in conceptual form, by using Navisworks we rendered a multi-dimensional model (3-D Model) as a result we gained a realistic view of the highways appearance.

We then proceeded towards development of 4-D scheduling. The concept of scheduling in Navisworks is quite like that done in Primavera. A section of highway was isolated and taken as a standard, we then proceeded towards the scheduling of that section. As a result of said scheduling we simultaneously obtain a rendered image of each activity as it is completed, A compilation of all these activities renders a complete visual model of the cross-section of highway. Upon processing the timeline of the activities scheduled on Navisworks the software generates a simulation of the planned activities in the form of a visual representation.

Results displayed in Annex-D.

4.1.5 BENTLEY SYNCHRO

Like Navisworks 4-D scheduling can also be done on Bentley Synchro. The section isolated previously is imported to Bentley Synchro and scheduling of activities is done for that section. A result like Navisworks is obtained from it except for a rendered model.

Synchro provides a more convenient synchronization with primavera data and develops a similar schedule by importing the primavera project which can be then linked to a 3D model to obtain a 4D schedule.

Results displayed in Annex-E.

4.2 ANALYSIS

4.2.1 SCHEDULING/ CONSTRUCTION SEQUENCING:

In planning phase, we can employ the use of BIM for quick and easy analysis of varying alternate approaches. Similarly in scheduling phase by using BIM we can schedule activities and get a general overview of the time required for project completion as well as an optimum path is generated, critical activities are highlighted, and a path is generated which helps in acceleration of the construction and timely completion of project.

4.2.2 VISUALIZATION

3-D Model

- With the help of BIM, we can generate 3-D models.
- The 3-D models give us a visual aid in identification and studying of specific components of the highway.

4-D Scheduling

- With help of BIM, we can perform scheduling of the construction activities and as a result a visual simulation of the completion of each activity is generated.
- A vague representation of the visual appearance of the project can also be obtained which aides in further understanding of the project.
- The 4-D product obtained from previous works helps in preparing Quantity takeoffs. This helps in cost estimation of the project.
- BIM helps in efficient budgeting of the project as compared to its predecessors. Manual work on the other hand is also very laborious and tiring. Therefore, has brought ease in this aspect as well.

4.2.3 CLASH DETECTION

- BIM helps in detecting real time physical hurdles i.e., if there is a difference in elevation between a bridge deck and its preceding road the software will automatically detect this and will suggest an alternative course of action.
- Apart from physical hurdles it has the capability to detect a possible dimensional clash as well for example if there is an activity in the fifth dimension whose quantity has been taken off (its cost has been estimated) but, it does not have an assigned timeline in the fourth dimension (scheduling), meaning that it has not been scheduled, BIM will automatically detect this and will inform the user of this ambiguity.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

OVERVIEW:

This chapter primarily focuses on the conclusion of our study, the intrigue surrounding BIM and the prominent queries regarding the use of BIM in the road and highway construction industry are jotted down. Furthermore, recommendations regarding the enhancement of highway construction and primarily the scheduling phase of construction activities involved in it.

5.1 CONCLUSIONS

In relation to our objectives, following are the major conclusions drawn from our project:

- BIM Application to Highway Construction:
  - The platform of BIM had previously been limited to the modelling and analysis of buildings, but further exploration has allowed us to use this platform for the information modelling of roads and highways.
  - Scheduled projects if integrated with BIM provide a whole new world of opportunities.
  - The employment of BIM in road and highway construction enhances the efficiency of the overall work particularly regarding time management, cost reduction, increase in safety and overall a better product is ensured.
- Integration of Primavera with BIM
  - The study conducted sheds light on how BIM provides a very high quality and efficient approach towards project management in highway construction.
- Comparative Matrix Between BIM Integrated Projects and Primavera Alone
  - The environment BIM provides is far superior to a restricted primavera-only scheduled project.
  - BIM helps in conceiving a vague visualization of the product. It also optimizes the use of valuable resources; the construction performance is also enhanced.
  - BIM provides a multi-dimensional environment and the ability to run simulations in the planning phase. This provides user with a control environment whereby simulating a variety of scenarios any problems that may arise can be dealt with prior to initiation.
  - Clash detection a prominent feature of BIM helps in detecting any problem whether it exists in the virtual or physical dimensions.
  - Not as limited as its predecessors, we can use BIM for the optimized operation and maintenance of road and highway projects.
  - BIM integrated projects give a multi-dimensional picture of the project strengthening the prior unidimensional Primavera schedule.

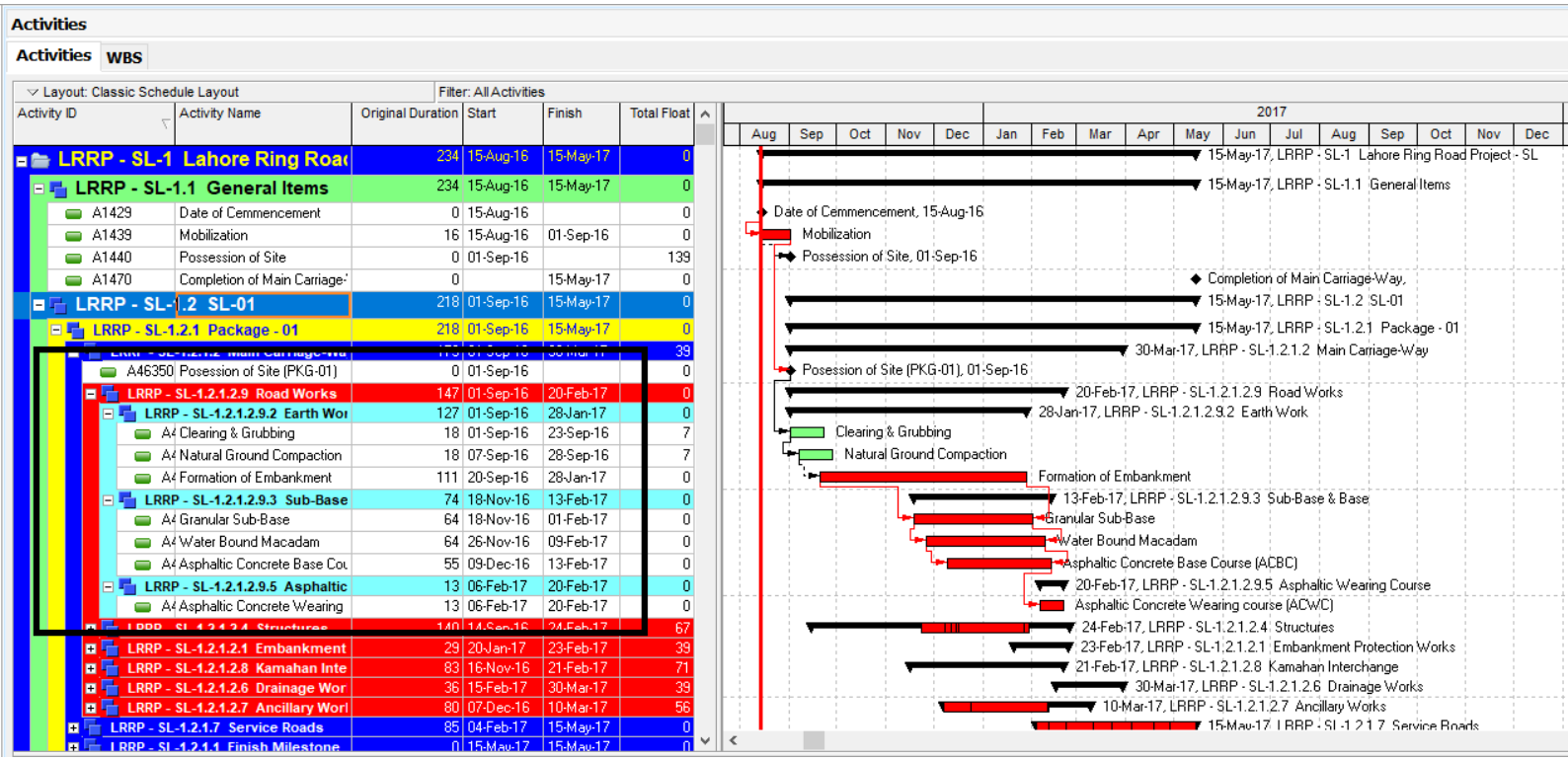
5.2 LIMITATIONS:

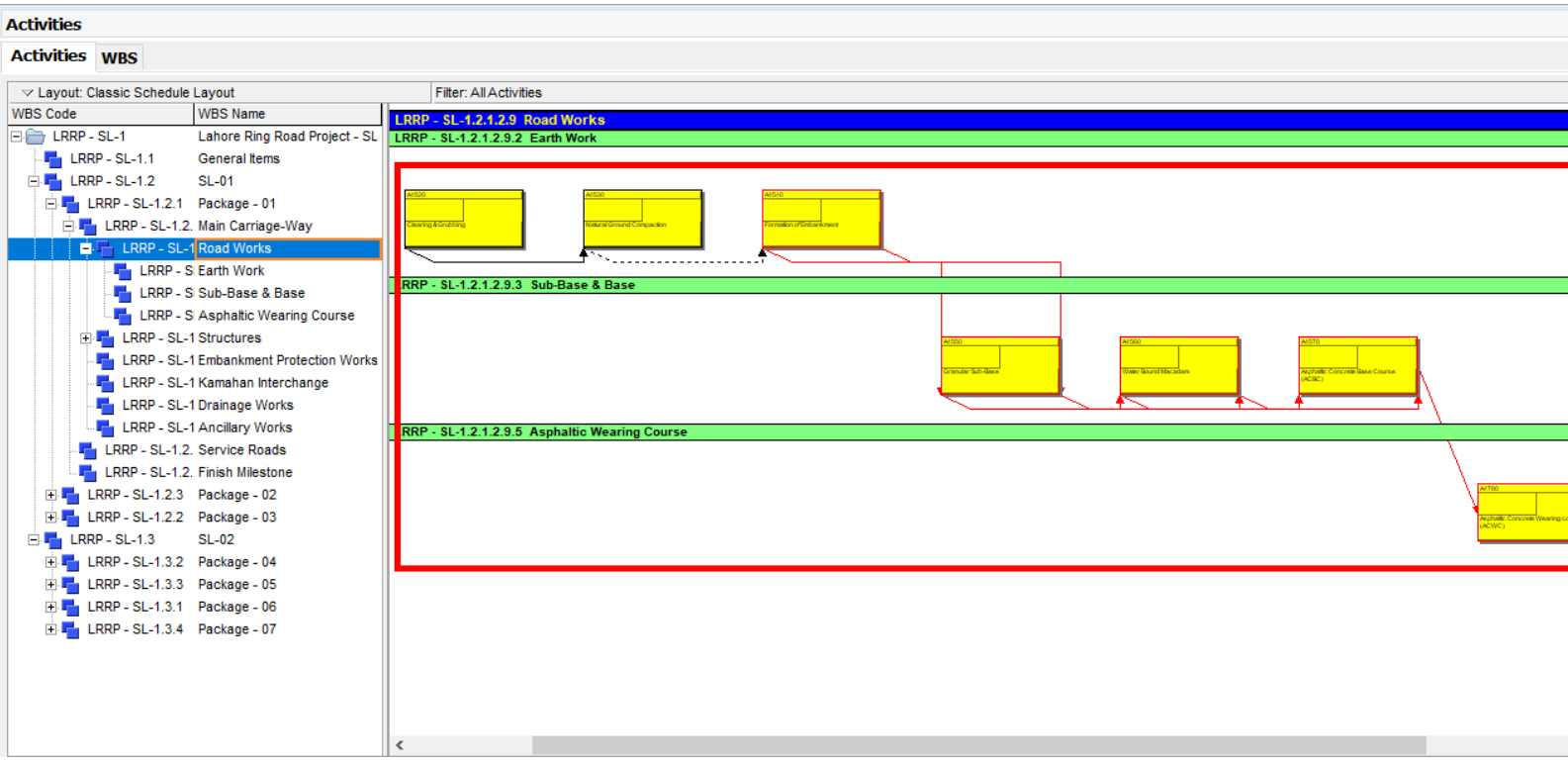
- The presence of too many conventional minds in the industry and existing technophobia amongst the old school of thought, BIM has not been integrated into modern construction practices.
- The lack of qualified technical staff and superstition amongst the investors has hindered the adoption of BIM in the industry.
- In our case a lack of LIDAR and aerial surveys led to acquisition of archived digital 3-D models available on the internet. The problem with these models is that they are less accurate.

5.3 RECOMMENDATIONS:

- BIM has many advantages and brings ease into every phase of the construction project ranging from the planning, initiation, execution, operation, and maintenance of a construction project and therefore it should be utilized in transportation sector for new as well as already completed projects.
- The study unveils that BIM can be used to proceed in various dimensions of a project for example a multi-dimensional approach can be employed for cost estimation purposes of a highway project.
- The study also shows that you can compare the efficiency of BIM in road and highway construction compared to manual laborious techniques. BIM has many advantages and brings ease into every phase of the construction project ranging from the planning, initiation, execution, operation, and maintenance of a construction project and therefore it should be used in road and highway construction industry as well.

Annexure-A


Activities
Activities
WBS
Layout: Classic Schedule Layout
Filter: All Activities
Activity ID
Activity Name
Original Duration
Start
Finish
Total Float
LRRP - SL-1 Lahore Ring Road
234 15-Aug-16 15-May-17 0
LRRP - SL-1.1 General Items
234 15-Aug-16 15-May-17 0
A1429 Date of Commencement 0 15-Aug-16 0
A1439 Mobilization 16 15-Aug-16 01-Sep-16 0
A1440 Possession of Site 0 01-Sep-16 139
A1470 Completion of Main Carriage- 0 15-May-17 0
LRRP - SL-1.2 SL-01
218 01-Sep-16 15-May-17 0
LRRP - SL-1.2.1 Package - 01
218 01-Sep-16 15-May-17 0
39
A46350 Posession of Site (PKG-01) 0 01-Sep-16 0
LRRP - SL-1.2.1.2.9 Road Works
147 01-Sep-16 20-Feb-17 0
LRRP - SL-1.2.1.2.9.2 Earth Wo
127 01-Sep-16 28-Jan-17 0
A4 Clearing & Grubbing 18 01-Sep-16 23-Sep-16 7
A4 Natural Ground Compaction 18 07-Sep-16 28-Sep-16 7
A4 Formation of Embankment 111 20-Sep-16 28-Jan-17 0
LRRP - SL-1.2.1.2.9.3 Sub-Base
74 18-Nov-16 13-Feb-17 0
A4 Granular Sub-Base 64 18-Nov-16 01-Feb-17 0
A4 Water Bound Macadam 64 26-Nov-16 09-Feb-17 0
A4 Asphaltic Concrete Base Cou 55 09-Dec-16 13-Feb-17 0
LRRP - SL-1.2.1.2.9.5 Asphaltic
13 06-Feb-17 20-Feb-17 0
A4 Asphaltic Concrete Wearing 13 06-Feb-17 20-Feb-17 0
67
LRRP - SL-1.2.1.2.1 Embankment
29 20-Jan-17 23-Feb-17 39
LRRP - SL-1.2.1.2.8 Kamahan Inte
83 16-Nov-16 21-Feb-17 71
LRRP - SL-1.2.1.2.6 Drainage Wor
36 15-Feb-17 30-Mar-17 39
LRRP - SL-1.2.1.2.7 Ancillary Worl
80 07-Dec-16 10-Mar-17 56
LRRP - SL-1.2.1.7 Service Roads
85 04-Feb-17 15-May-17 0
2017
Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
15-May-17, LRRP - SL-1 Lahore Ring Road Project - SL
15-May-17, LRRP - SL-1.1 General Items
Date of Commencement, 15-Aug-16
Mobilization
Possession of Site, 01-Sep-16
Completion of Main Carriage-Way,
15-May-17, LRRP - SL-1.2 SL-01
15-May-17, LRRP - SL-1.2.1 Package - 01
30-Mar-17, LRRP - SL-1.2.1.2 Main Carriage-Way
Posession of Site (PKG-01), 01-Sep-16
20-Feb-17, LRRP - SL-1.2.1.2.9 Road Works
28-Jan-17, LRRP - SL-1.2.1.2.9.2 Earth Work
Clearing & Grubbing
Natural Ground Compaction
Formation of Embankment
13-Feb-17, LRRP - SL-1.2.1.2.9.3 Sub-Base & Base
Granular Sub-Base
Water Bound Macadam
Asphaltic Concrete Base Course (ACBC)
20-Feb-17, LRRP - SL-1.2.1.2.9.5 Asphaltic Wearing Course
Asphaltic Concrete Wearing course (ACWC)
24-Feb-17, LRRP - SL-1.2.1.2.4 Structures
23-Feb-17, LRRP - SL-1.2.1.2.1 Embankment Protection Works
21-Feb-17, LRRP - SL-1.2.1.2.8 Kamahan Interchange
30-Mar-17, LRRP - SL-1.2.1.2.6 Drainage Works
10-Mar-17, LRRP - SL-1.2.1.2.7 Ancillary Works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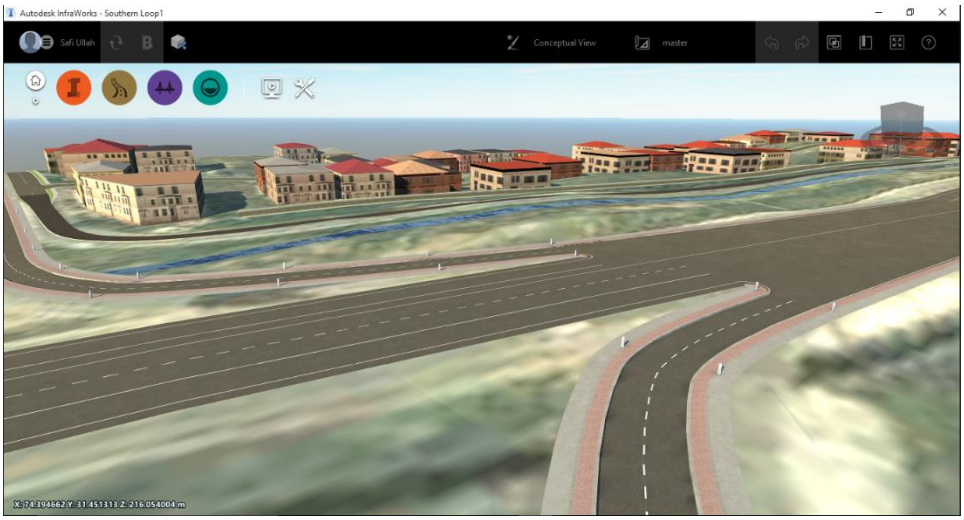
LRRP - SL-1.1 General Items
LRRP - SL-1.2 SL-01
LRRP - SL-1.2.1 Package - 01
LRRP - SL-1.2. Main Carriage-Way
LRRP - SL- Road Works
LRRP - S Earth Work
LRRP - S Sub-Base & Base
LRRP - S Asphaltic Wearing Course
LRRP - SL-1 Structures
LRRP - SL-1 Embankment Protection Works
LRRP - SL-1 Kamahan Interchange
LRRP - SL-1 Drainage Works
LRRP - SL-1 Ancillary Works
LRRP - SL-1.2. Service Roads
LRRP - SL-1.2. Finish Milestone
LRRP - SL-1.2.3 Package - 02
LRRP - SL-1.2.2 Package - 03
LRRP - SL-1.3 SL-02
LRRP - SL-1.3.2 Package - 04
LRRP - SL-1.3.3 Package - 05
LRRP - SL-1.3.1 Package - 06
LRRP - SL-1.3.4 Package - 07
LRRP - SL-1.2.1.2.9 Road Works
LRRP - SL-1.2.1.2.9.2 Earth Work
RRP - SL-1.2.1.2.9.3 Sub-Base & Base
RRP - SL-1.2.1.2.9.5 Asphaltic Wearing Course

Annexure-B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Safi Ullah
Conceptual View
master


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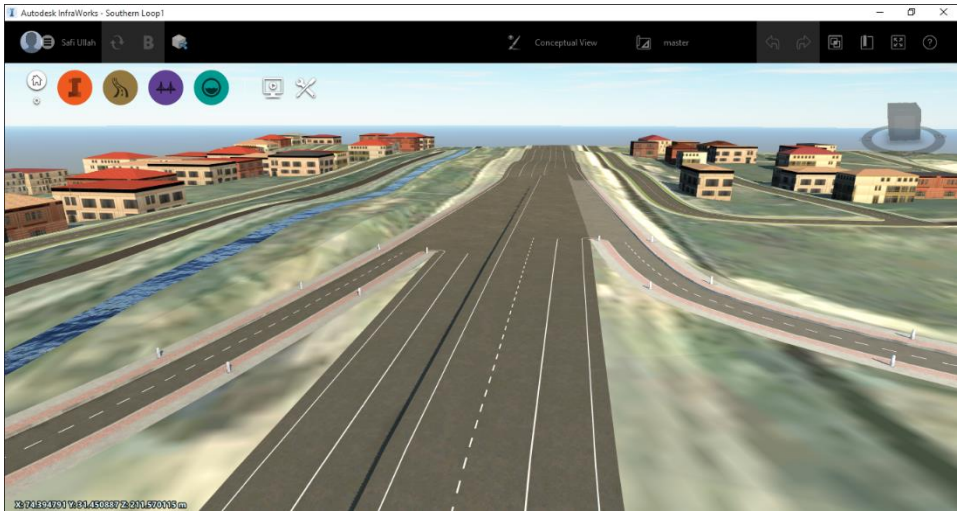
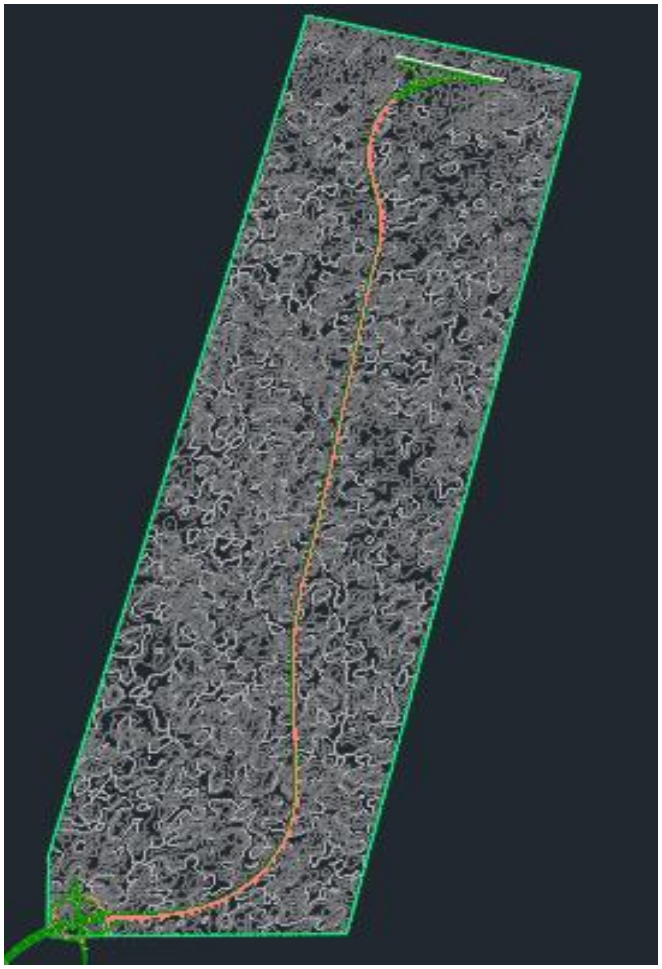
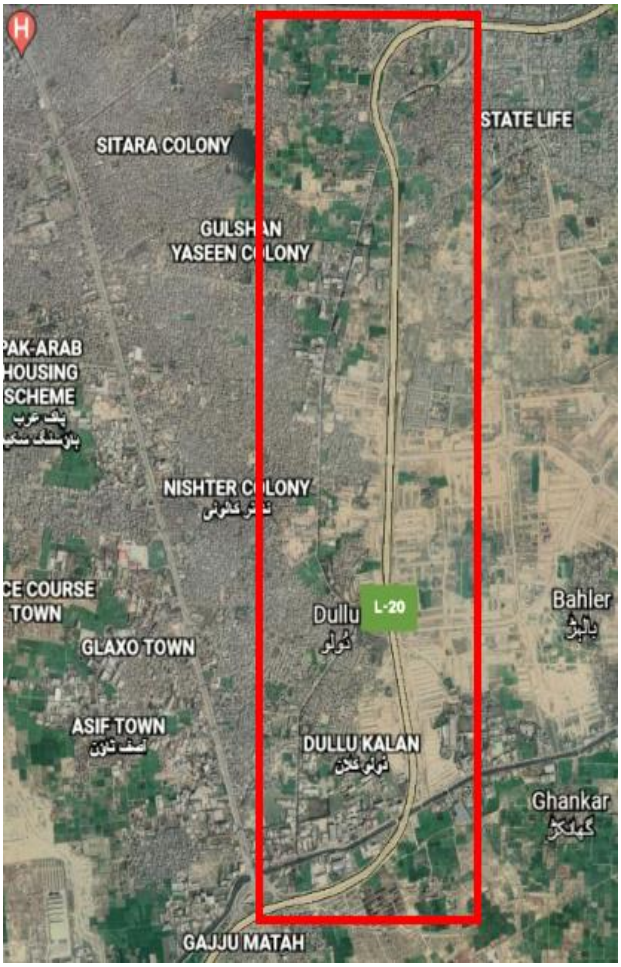
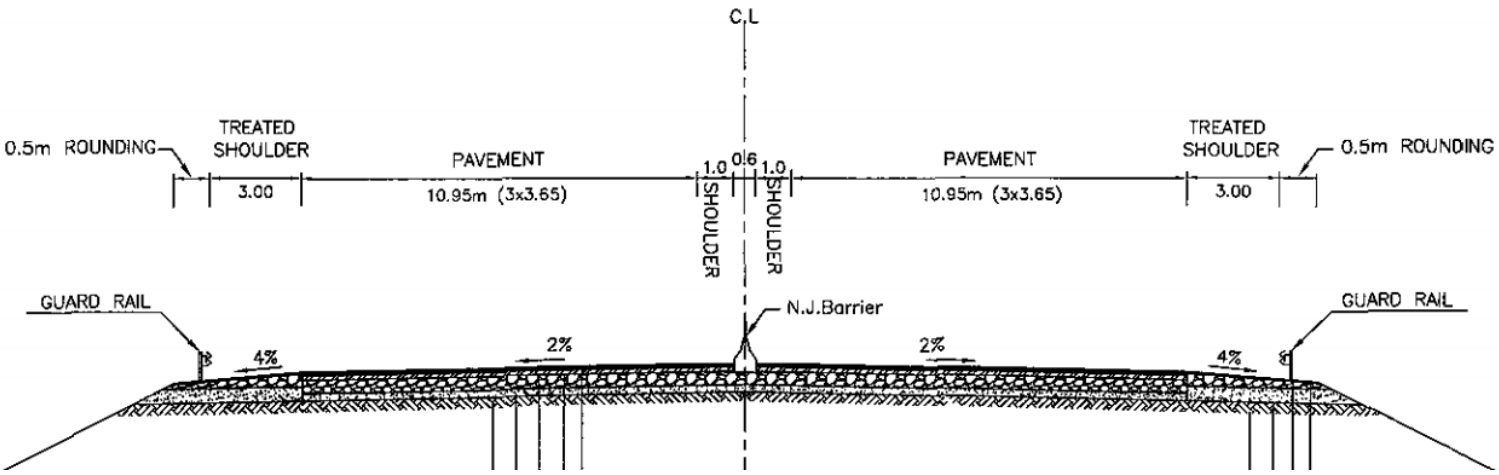
Safi Ullah
Conceptual View
master

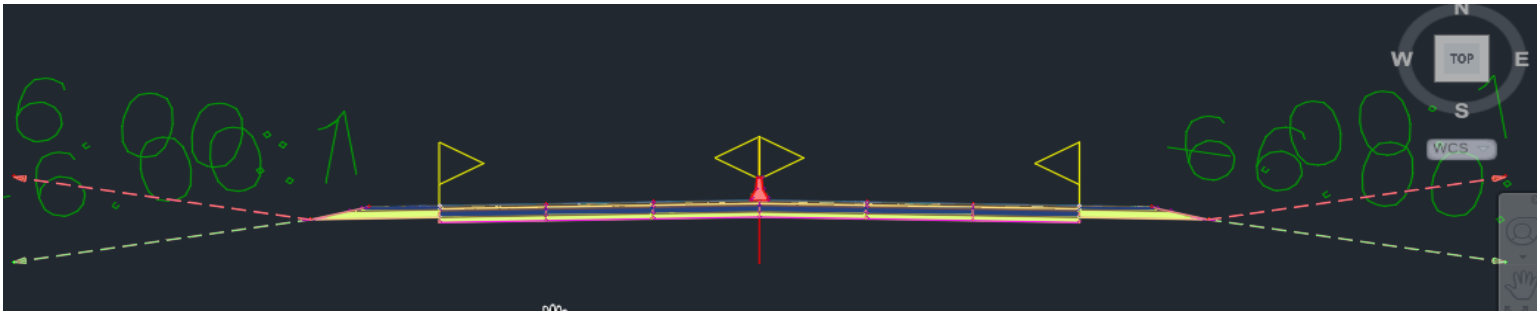

Autodesk InfraWorks - Southern Loop1
Safi Ullah
Conceptual View
master

Annexure-C




SITARA COLONY
STATE LIFE
GULSHAN
YASEEN COLONY
PAK-ARAB
HOUSING
SCHEME
NISHTER COLONY
CE COURSE
TOWN
GLAXO TOWN
Dullu
L-20
Bahler
ASIF TOWN
DULLU KALAN
Ghankar
GAJJU MATAH


C.L
0.5m ROUNDING
TREATED SHOULDER
3.00
PAVEMENT
10.95m (3x3.65)
1.0
SHOULDER
0.6
1.0
SHOULDER
PAVEMENT
10.95m (3x3.65)
TREATED SHOULDER
3.00
0.5m ROUNDING
GUARD RAIL
4%
2%
N.J.Barrier
2%
4%
GUARD RAIL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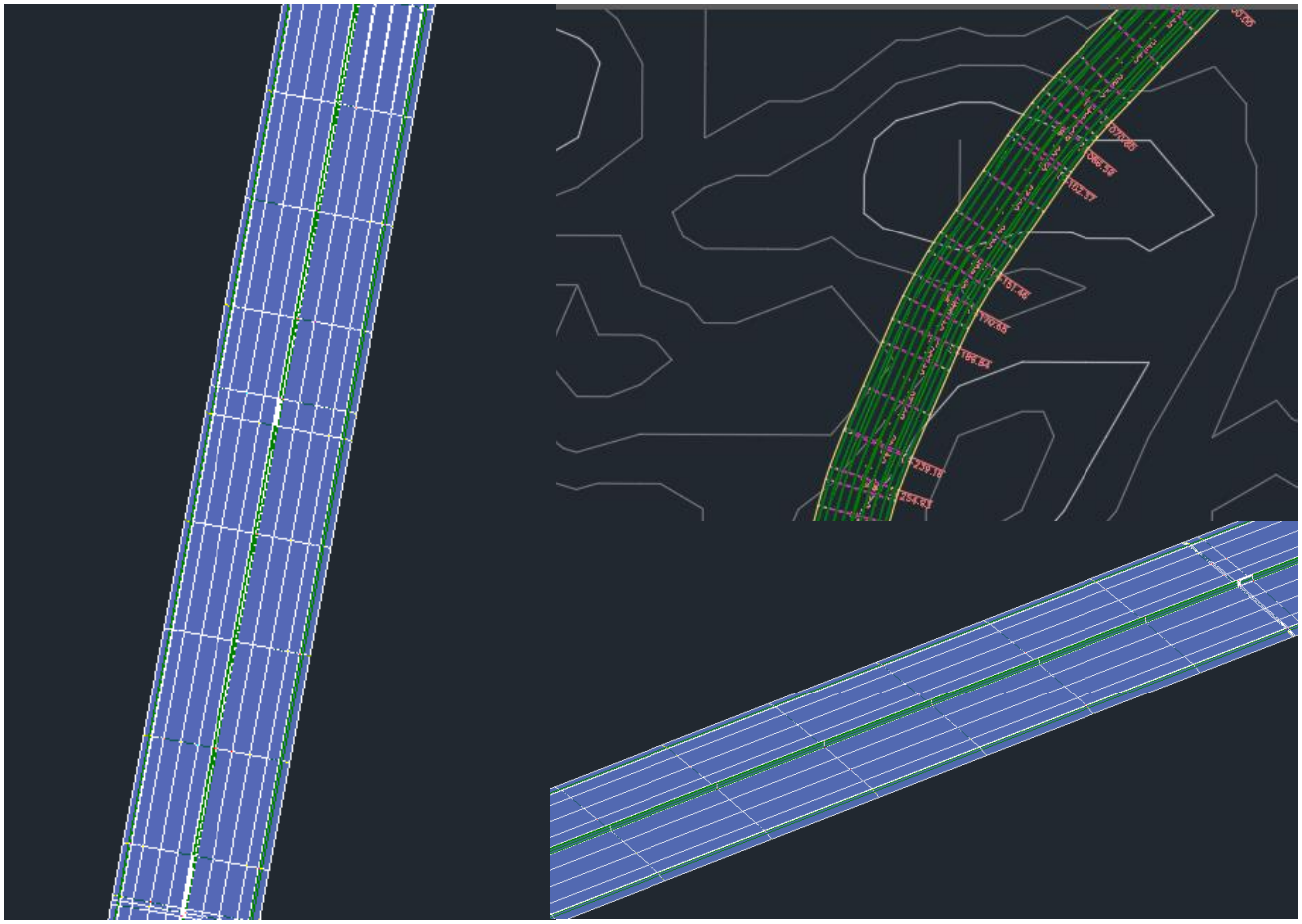
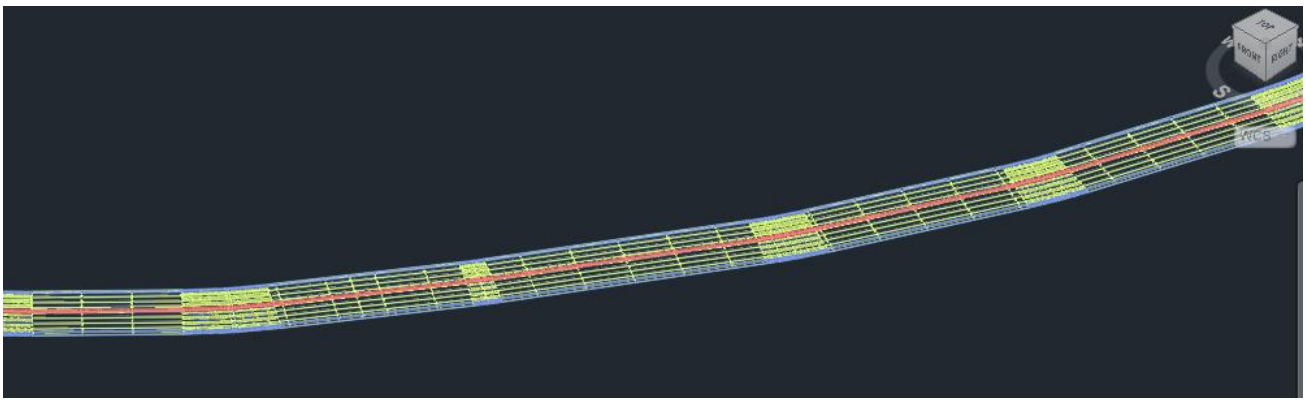
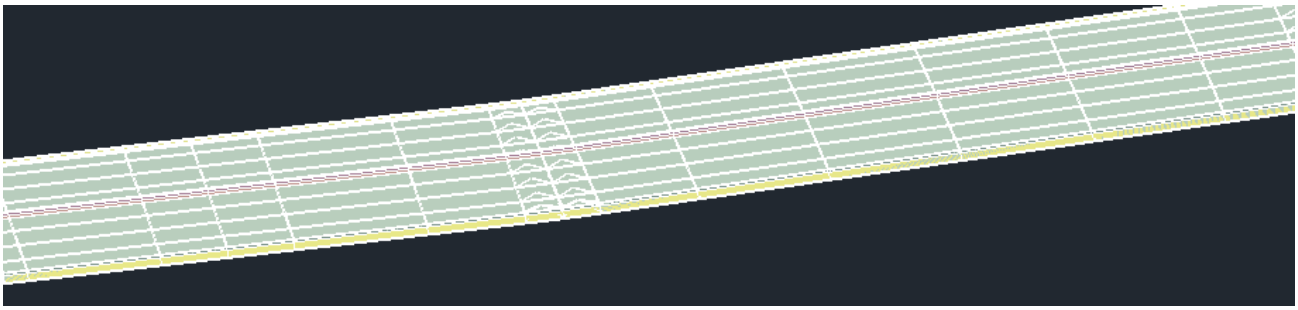
Annexure-C







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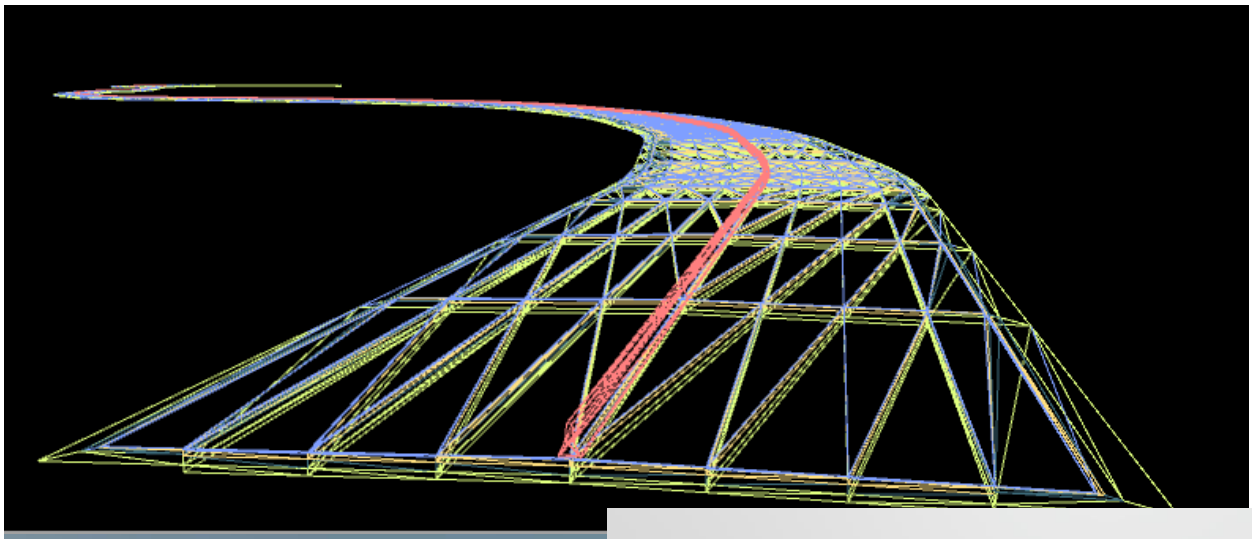

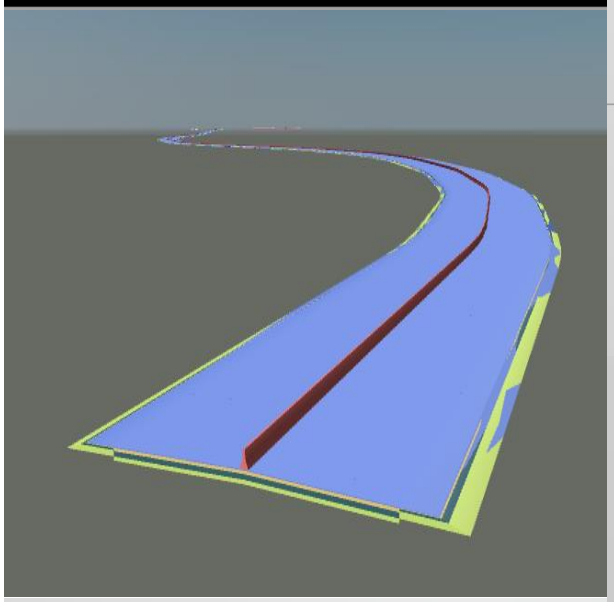

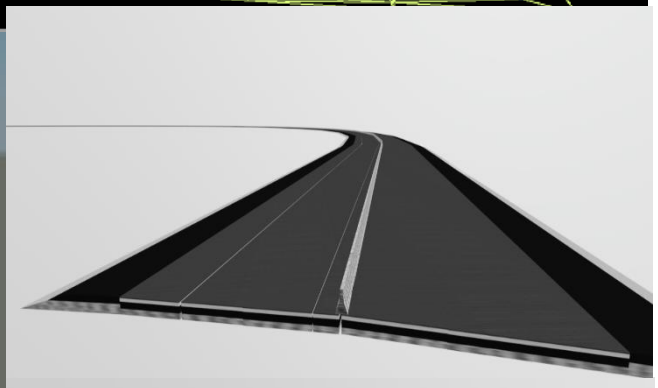

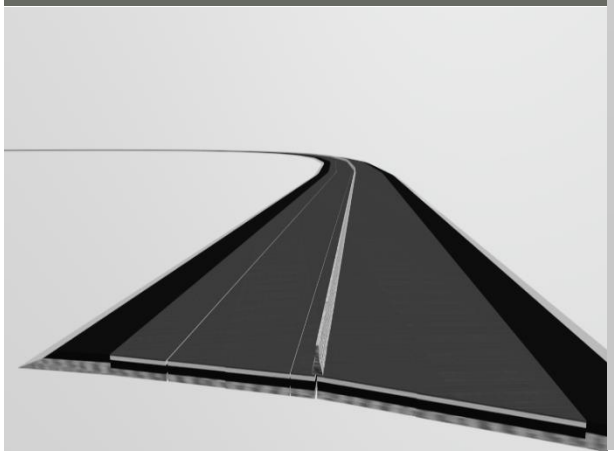

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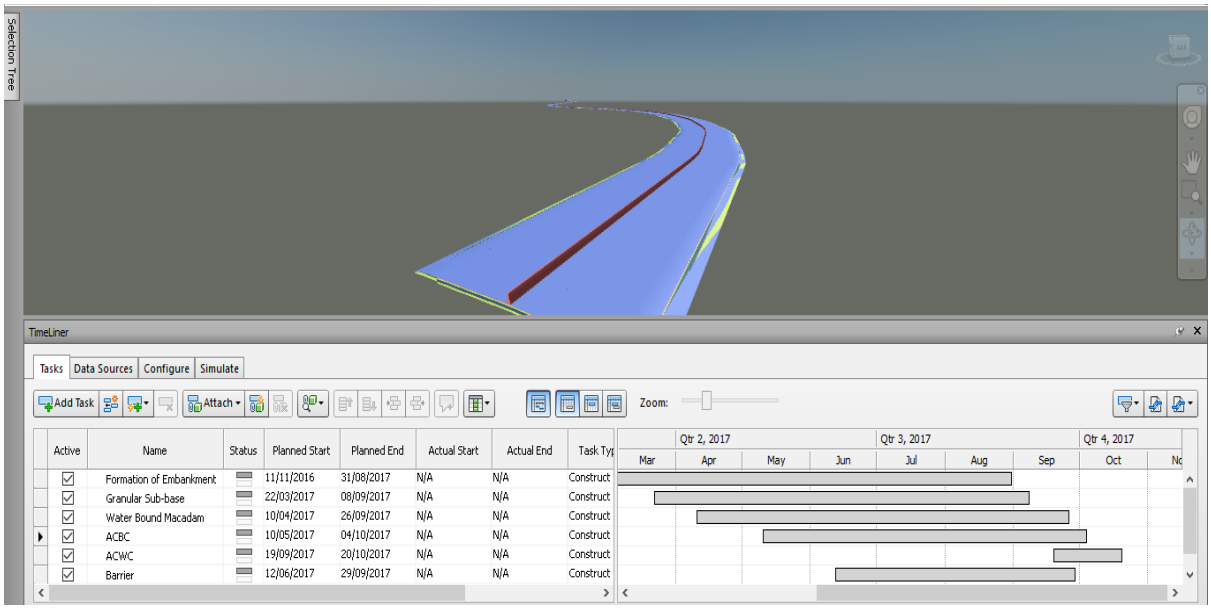
Selection Tree
TimeLiner
Tasks
Data Sources
Configure
Simulate
Add Task
Attach
Zoom:
Active
Name
Status
Planned Start
Planned End
Actual Start
Actual End
Task Typ
Formation of Embankment 11/11/2016 31/08/2017 N/A N/A Construct
Granular Sub-base 22/03/2017 08/09/2017 N/A N/A Construct
Water Bound Macadam 10/04/2017 26/09/2017 N/A N/A Construct
ACBC 10/05/2017 04/10/2017 N/A N/A Construct
ACWC 19/09/2017 20/10/2017 N/A N/A Construct
Barrier 12/06/2017 29/09/2017 N/A N/A Construct
Qtr 2, 2017
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Qtr 4, 2017
Mar
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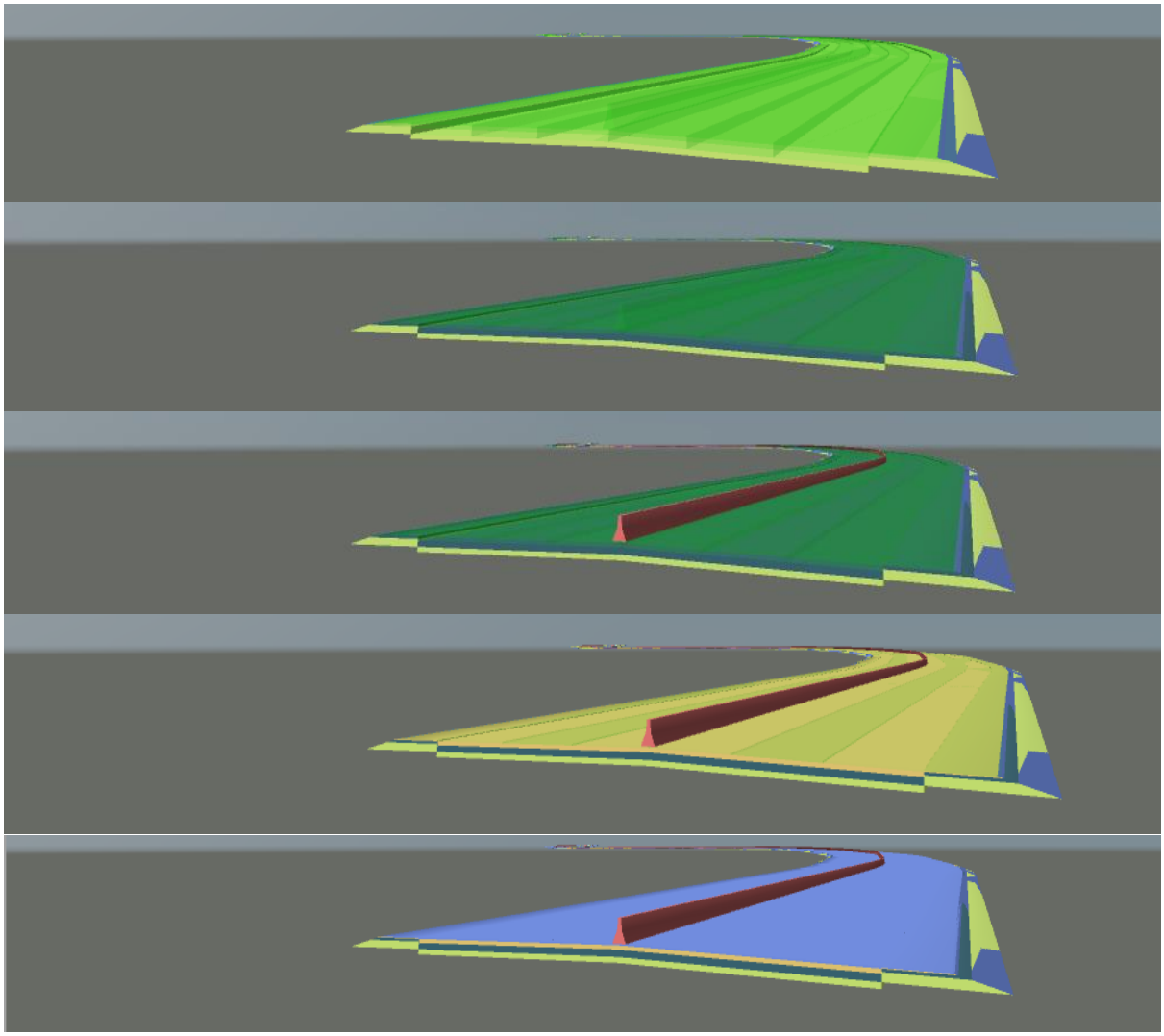

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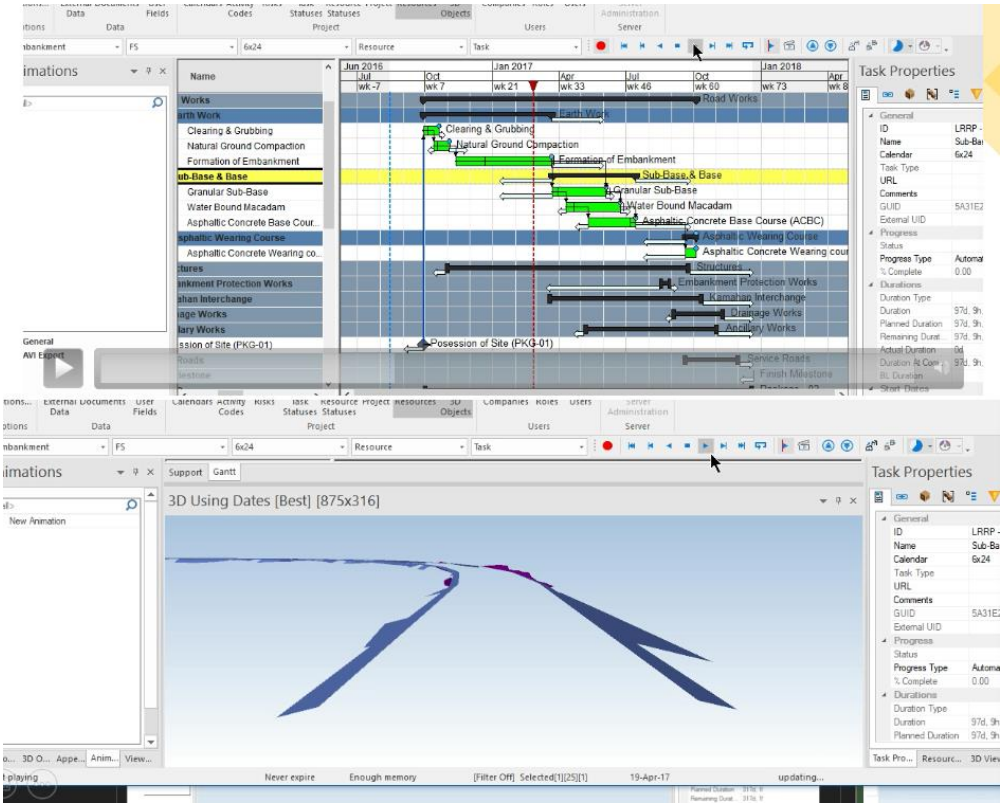
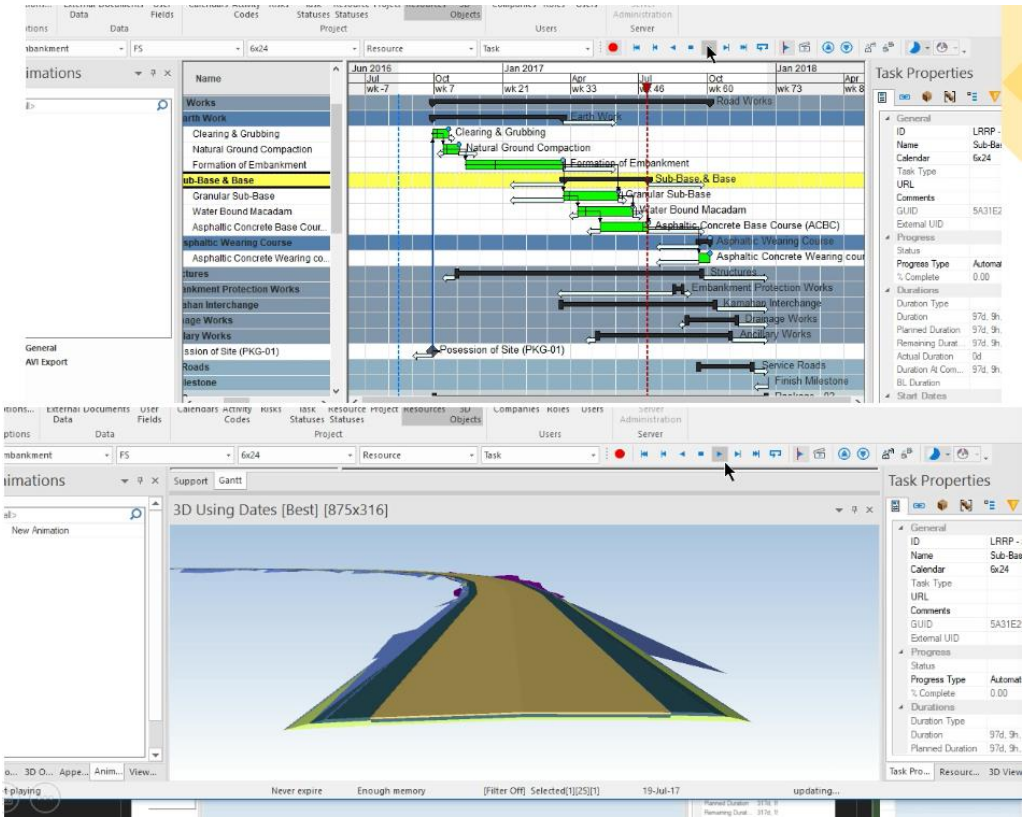

Name
Works
Clearing & Grubbing
Natural Ground Compaction
Formation of Embankment
Sub-Base & Base
Granular Sub-Base
Water Bound Macadam
Asphaltic Concrete Base Course (ACBC)
Asphaltic Concrete Wearing co...
Structures
Embankment Protection Works
Kamathan Interchange
Drainage Works
Ancillary Works
Posession of Site (PKG-01)
Service Roads
Finish Milestone
Jun 2016
Jan 2017
Jan 2018
Task Properties
3D Using Dates [Best] [875x316]
New Animation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Granular Sub-Base
Water Bound Macadam
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Structures
Embankment Protection Works
Kamathan Interchange
Drainage Works
Ancillary Works
Posession of Site (PKG-01)
Service Roads
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Jun 2016
Jan 2017
Jan 2018
Task Properties
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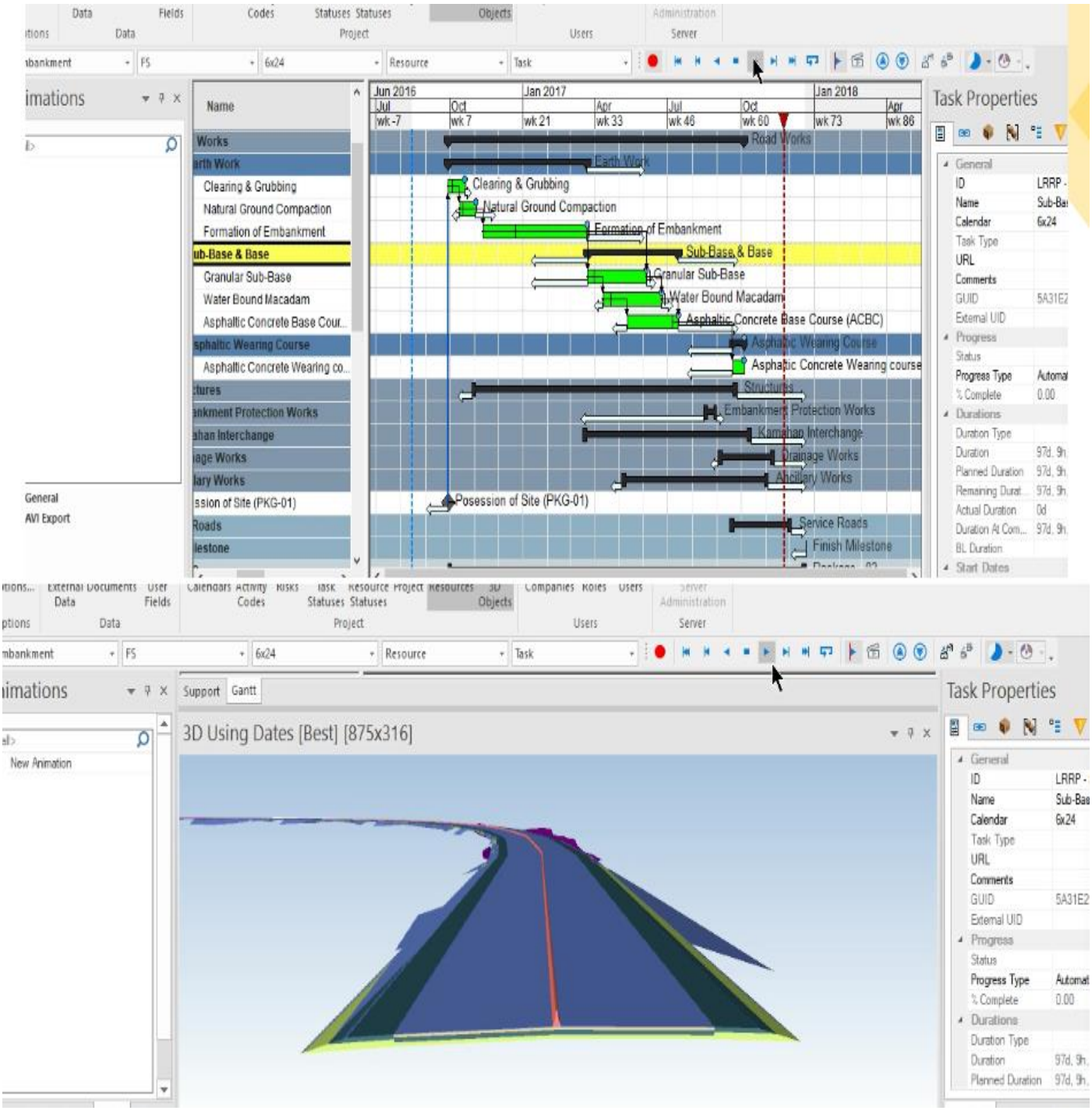
New Animation

Annexure-E


Jun 2016
Jan 2017
Jan 2018
Name
Works
Clearing & Grubbing
Natural Ground Compaction
Formation of Embankment
Sub-Base & Base
Granular Sub-Base
Water Bound Macadam
Asphaltic Concrete Base Cour...
Asphaltic Concrete Wearing co...
Roads
Road Works
Earth Work
Clearing & Grubbing
Natural Ground Compaction
Formation of Embankment
Sub-Base & Base
Granular Sub-Base
Water Bound Macadam
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Kamahan Interchange
Drainage Works
Ancillary Works
Posession of Site (PKG-01)
Service Roads
Finish Milestone
Task Properties
3D Using Dates [Best] [875x316]
Support
Gantt

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