AUTODESK UNIVERSITY

BES500178

Workflows to develop, manage & integrate Infrastructure BIM Projects

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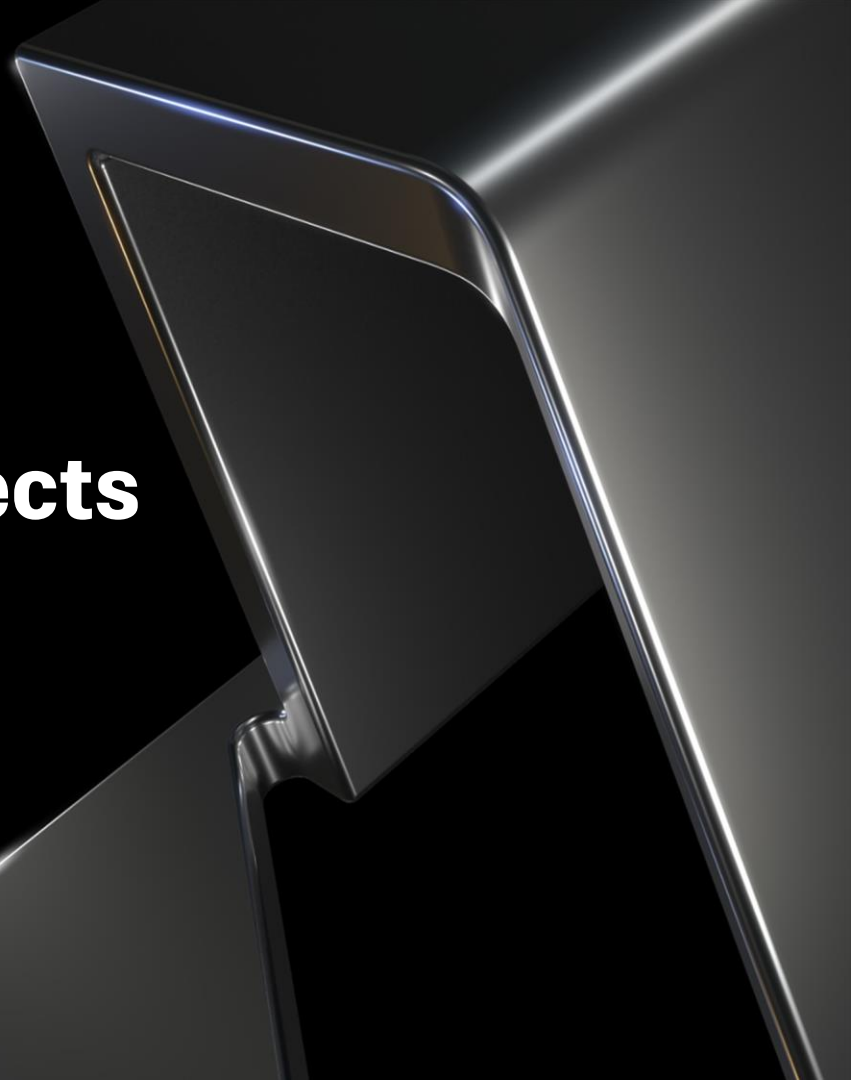


About the speakers

TECHTURE

Viraj Voditel

- Viraj is the Founder & Director of Techture, a global BIM consulting firm having offices in USA, UK, UAE, India and Singapore.
- He started out as a Student Expert for Autodesk while pursuing his Civil Engineering degree and currently is an Autodesk Expert Elite and a Certified Professional for various software.
- He is a BIM evangelist and frequently talks about BIM at various platforms. He has delivered technical lectures at the national and international level and is actively involved in championing the newest technologies in the AEC space.
- Viraj has been able to amass a rich experience on BIM Implementation for various large scale projects including hospitals, hotels, airports, hydropower projects and smart cities.
- He also actively works towards software development and technological innovation and is an advocate for the use of Cloud Computing in the AEC domain.

Dayesh Jaiswal

- Dayesh is a Director at Techture and has been spearheading lifecycle BIM execution on various projects and working with several government agencies to develop BIM implementation strategies. He emphasizes on digital project management techniques to enable better visibility and enhanced decision making for project owners.
- Acting as a technology consultant, he has worked with leading developers, contractors across the globe to augment current design and execution process of their industrial and building projects, through integrated project delivery processes.
- He also focuses on the infrastructure sector and has spearheaded BIM and related technology implementation on various Metros, Highways and urban infrastructure projects across India and Middle east

AUTODESK® EXPERT ELITE

AU SPEAKER 2017

SPEAKER
Autodesk University 2020
November 17-20
AUTODESK

Important Points

Some general points about this session

- As you're aware, this time AU 2021 is happening online, and thus, this is a prerecorded instructional demo.
- If you have any questions or comments, please drop them on the class page on the AU website. You're also recommended to attend my dedicated Q&A session during AU 2021 where some of the questions will be answered live.
- If you're watching this after AU 2021 is over, feel free to drop us an email with your questions, comments or constructive feedback on viraj.voditel@techture.global
- A Handout & this Presentation are also available for ready reference on the AU website.

Learning Objectives

LEARNING OBJECTIVE 1

Discover some upcoming trends in the AEC industry and how certain Autodesk solutions will help in their adoption

LEARNING OBJECTIVE 2

Learn the depth & detail at which tools can be utilized for modeling & coordination, & then further extended via integrations

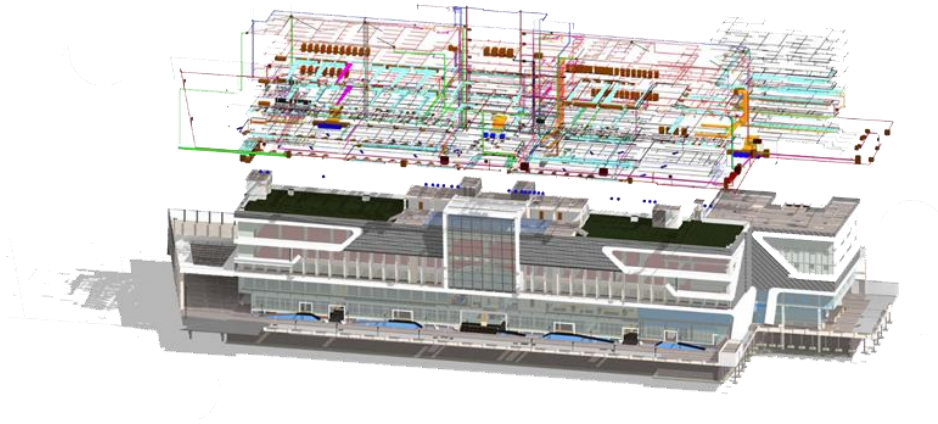
LEARNING OBJECTIVE 3

Understand how cloud technologies & data integration is quickly becoming the de facto standard in projects and organizations

LEARNING OBJECTIVE 4

Get to know advanced Rebar and structural fabrication workflows in Infrastructure projects through case studies

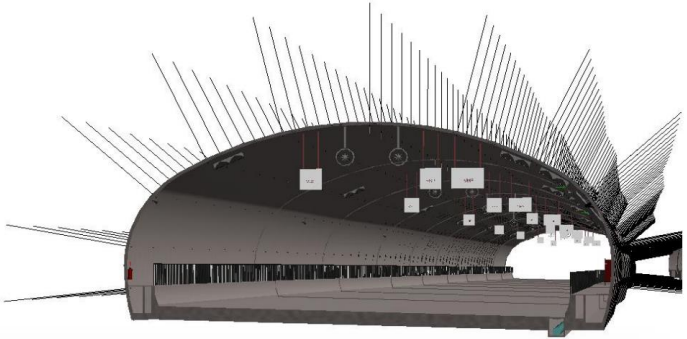
BIM Workflow for Building Projects

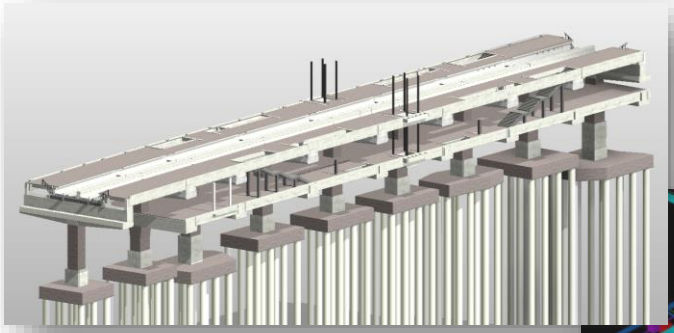


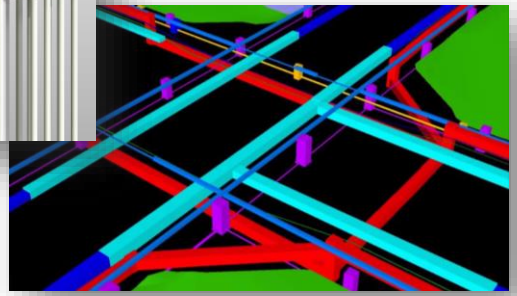
- Buildings specific BIM workflows have been well defined and documented over the years.
- The level of detail, information, definitions and 3D modelling tools have matured and are readily available.
- Various case studies published for 3D to 4D/5D/6D/7D workflows.
- The infrastructure sector still isn’t familiar to similar workflows and many ambiguities are still present.

Extending BIM to Infrastructure Projects

BIM for Infrastructure Projects







Techture has been a pioneer in extending BIM workflows from buildings to large scale infrastructure projects.

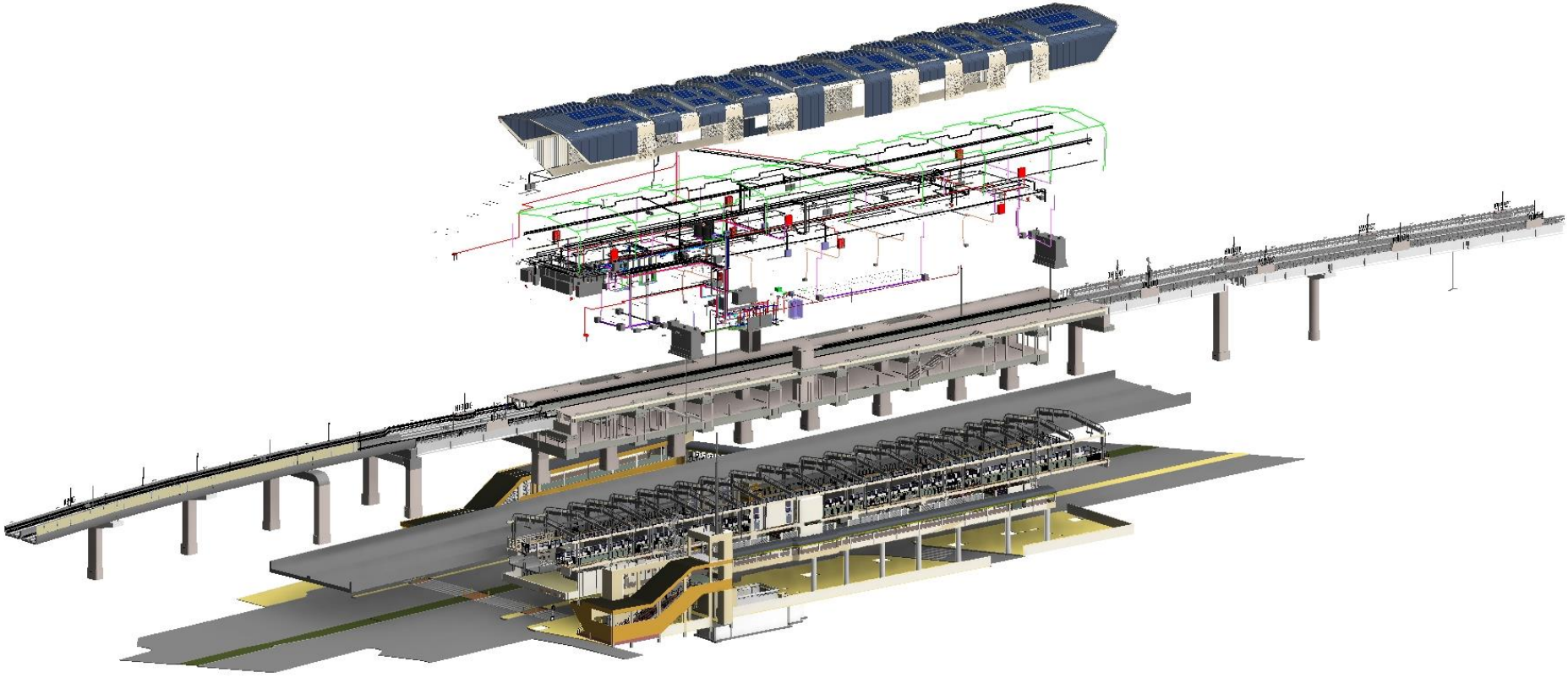
- We have developed customized workflows in Revit, Civil 3D, Infraworks, Navisworks & Autodesk Construction Cloud to deliver 3D – 7D BIM outputs to large Infrastructure projects.
- Not just modelling, Techture has utilized Forge and various applications available in AEC Collection and ACC
- Techture has extensively utilized Cloud to provide integrated project management tools for various Infrastructure projects.

We will look at some case studies from large Indian construction projects where **Autodesk** tools were successfully utilized.

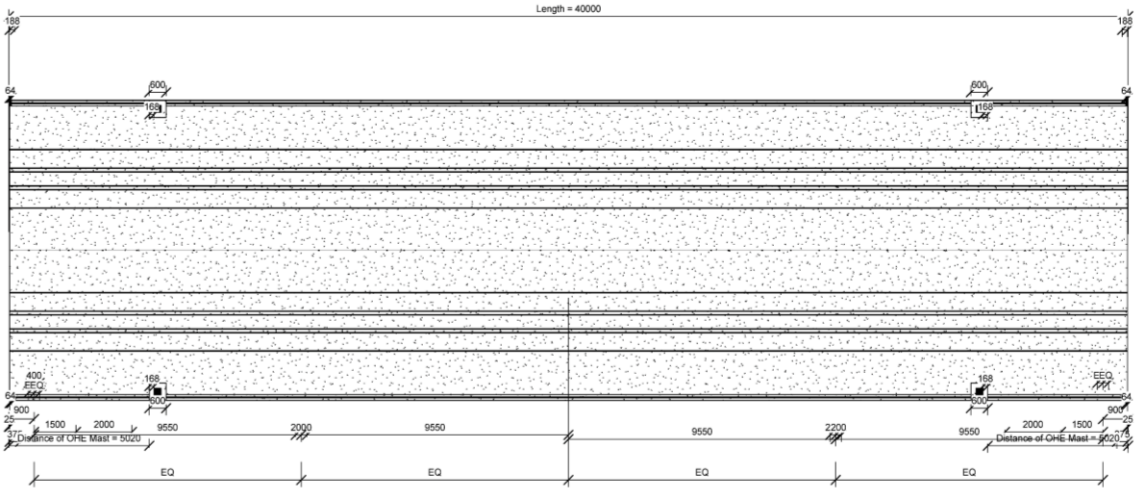
Case Study - Delhi Metro

Complete 3D-5D Model development through Autodesk Tools.

Scale – 12.5 km Viaduct & 10 Elevated stations



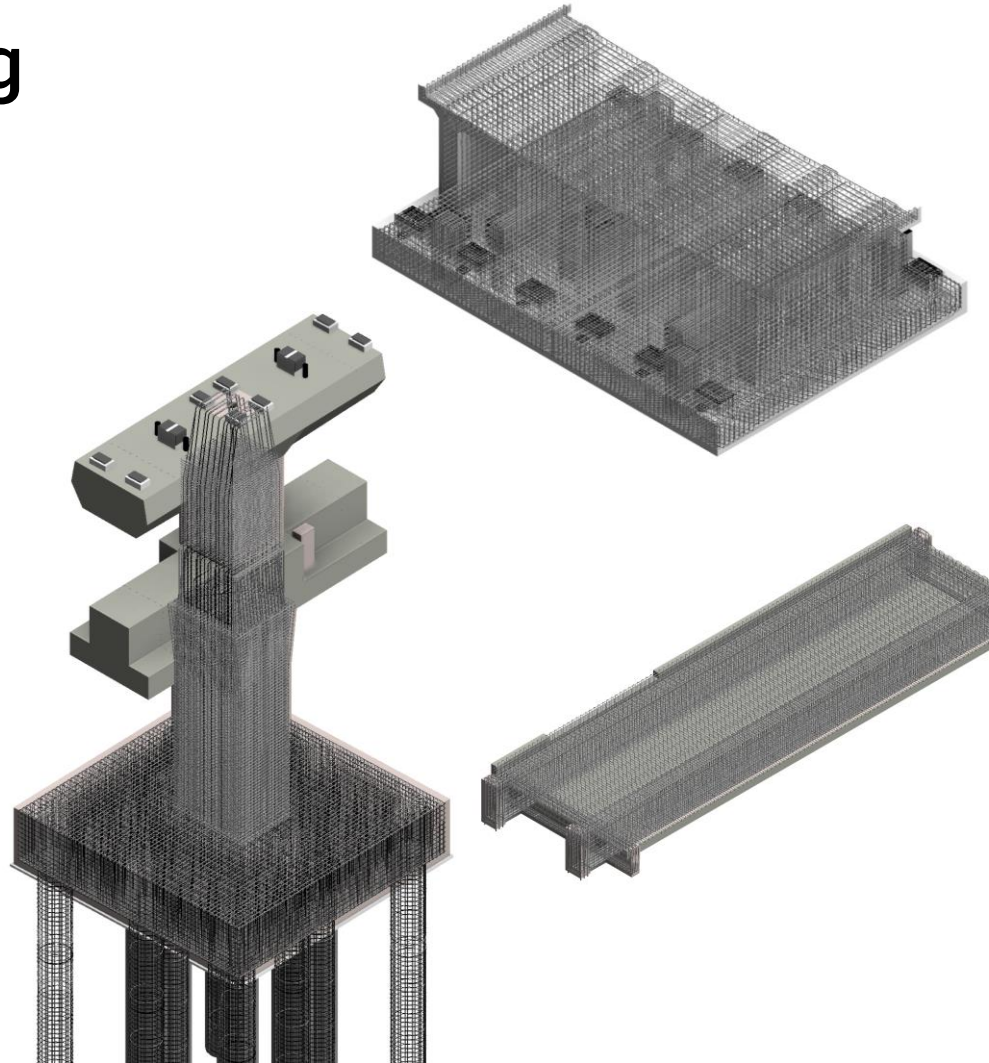
Creating Complex Parametric Families



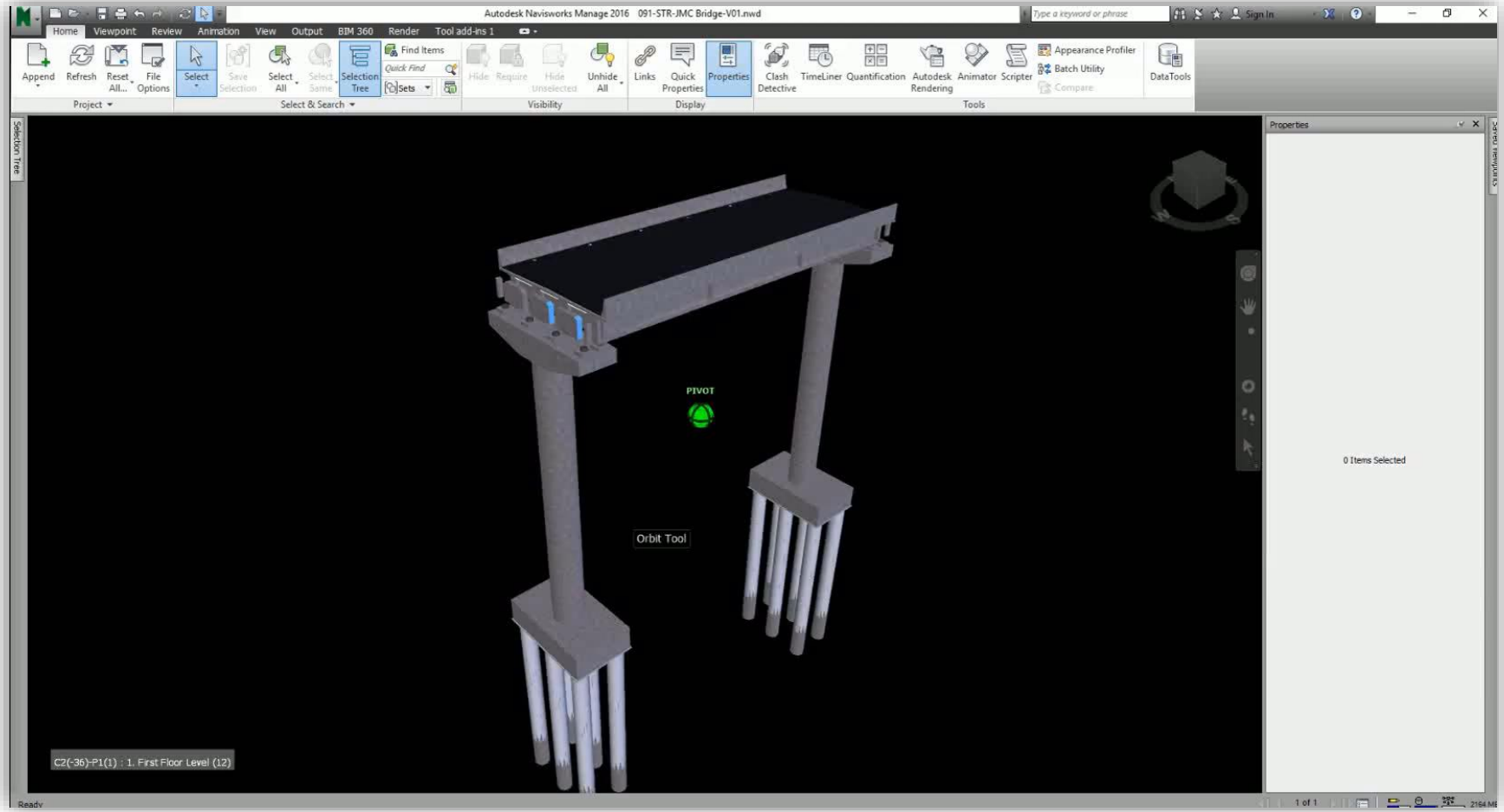
- Customized Parametric families were created in this project for elements like Viaduct U-Girder, T-Girder, Pi-Girders, etc.
- The main challenge was to define the length, angle of curvature, openings for lifting holes, shear block cut outs, drain pipe cutout, bearing locations, cable tray hangers, etc.
- Dynamo scripts were used for placing the girder along the Alignment centerline which was created using Civil3D.

Reinforcement Modelling

- Reinforcement Modelling was done for the structural elements as per the design.
- Clash Coordination was done for the Reinforcement Model to check the feasibility of the design.
- BBS was created to get the quantity from the model and to aid the construction process.
- GFC drawings were extracted from the model to be sent to site for construction.

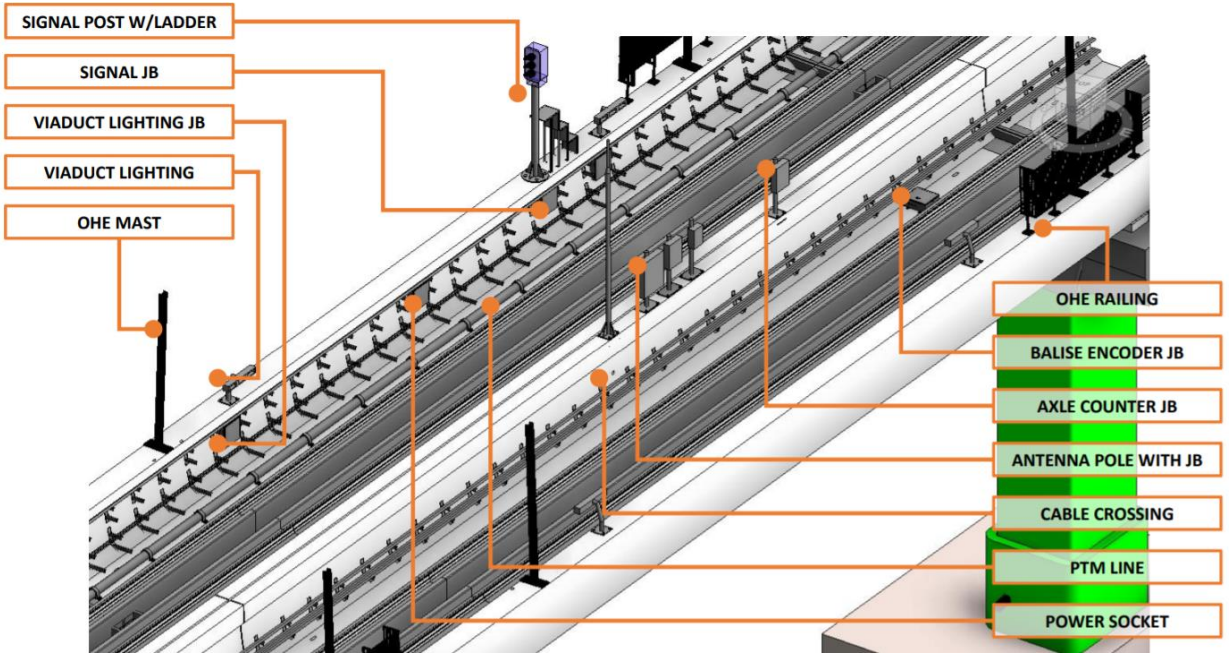


Reinforcement Modelling



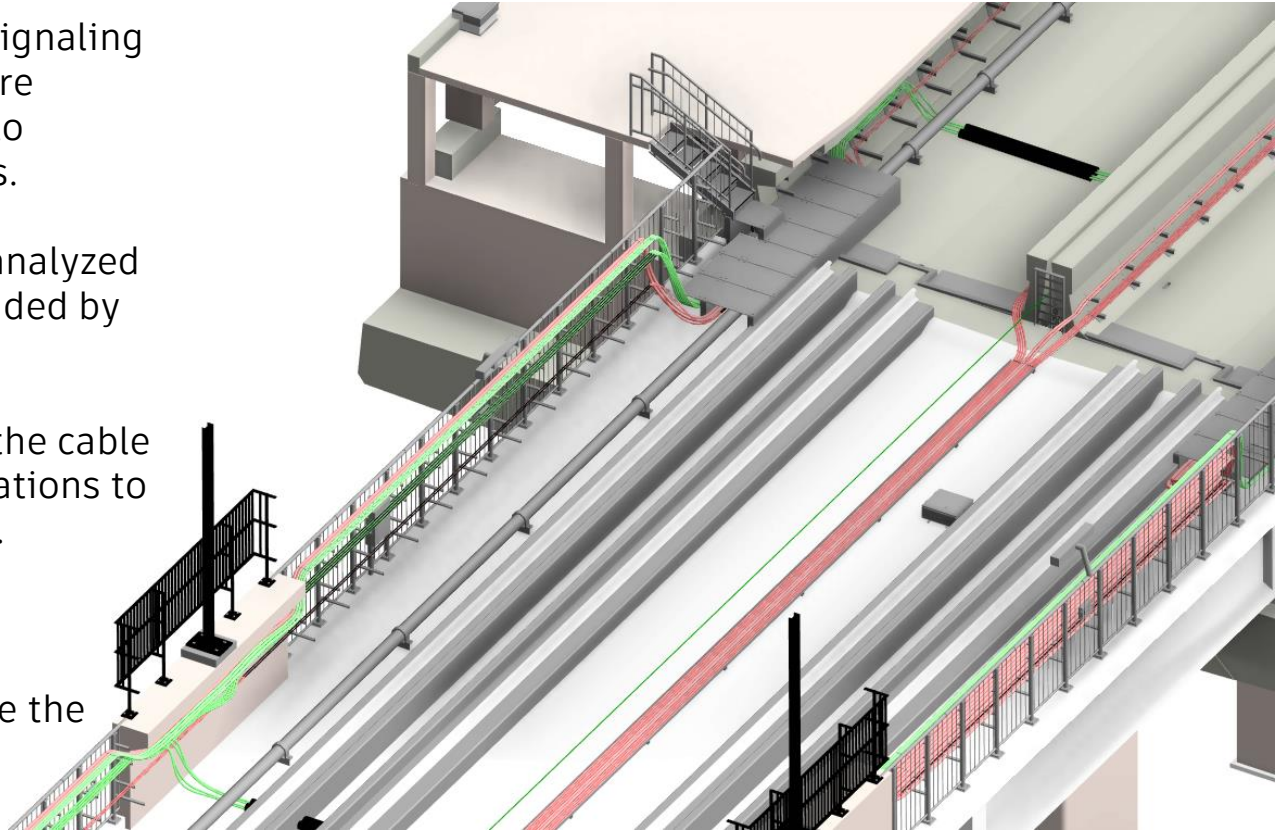
Signaling & Telecommunication Modelling

- No proper drawings are available for S&T due to which majority decisions are taken on site
- BIM Models provided a way to visualize the accurate positions of cross-overs and establishing locations of other components.
- BIM helped enable coordination with other disciplines and determine position of structural cutouts



Signaling & Telecommunication Modelling

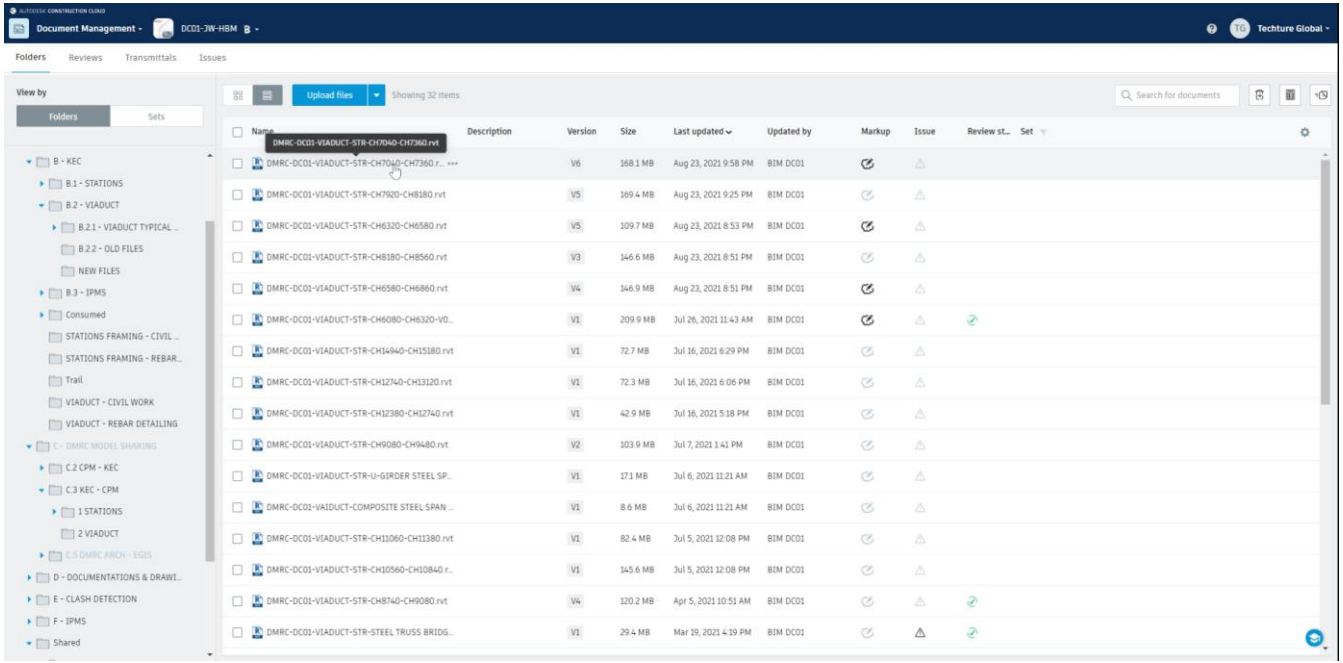
- Equipment and cables for Signaling and Telecommunication were modelled over the viaduct to represent the S&T elements.
- This model is then further analyzed to validate the design provided by the consultants.
- It was also used to design the cable routing at the interface locations to check for space availability. Furthermore, elements like staircases, cable hangers, pedestals etc., were redesigned to accommodate the cables within the design



Model & Sheet Collaboration on the Cloud

The project is hosted on BIM360.

BIM360 forms the common platform for Document Exchange, Model Hosting, Sheets and Models Approval System, Issue Creation and Design Coordination.



Design Validation

Quantification

Quantities were extracted from the model at various stages of the project like Tender stage, Construction stage.

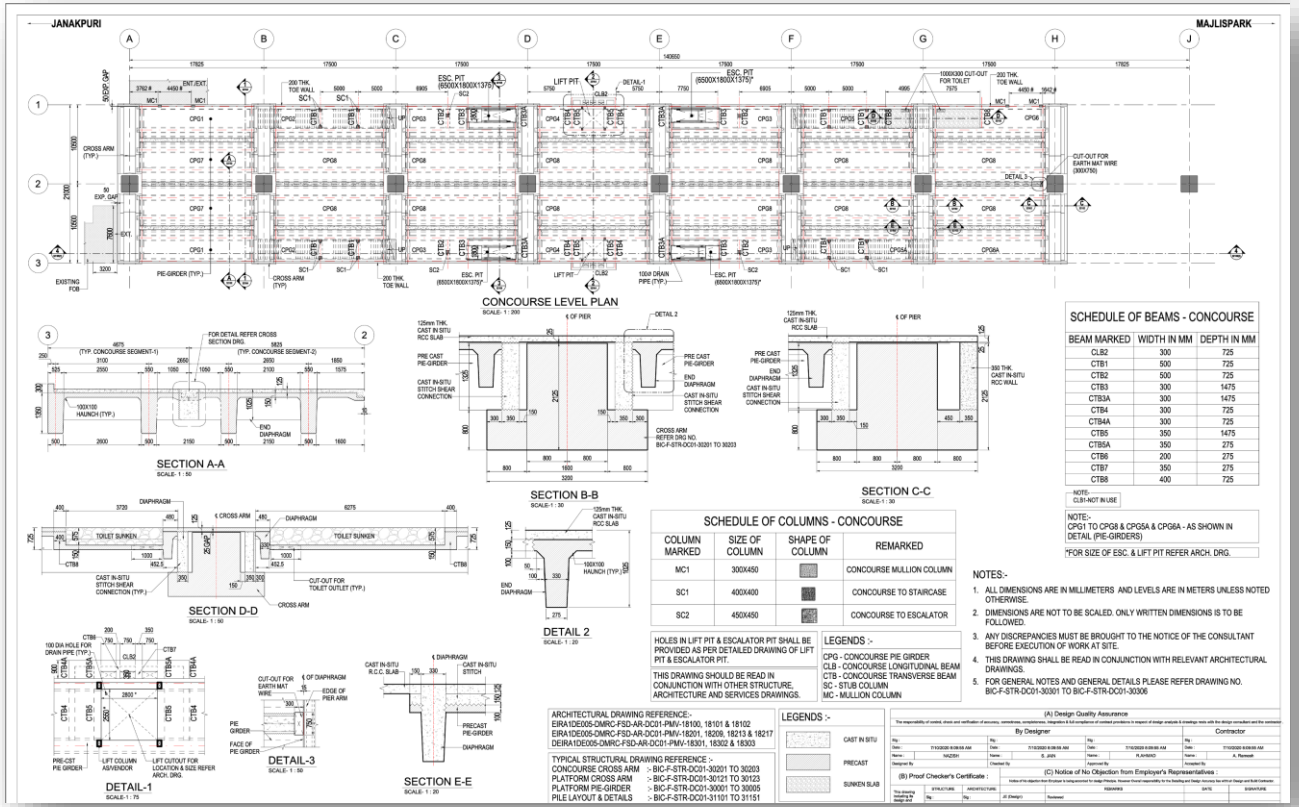
These quantities were then used for various activities like feasibility check, procurement, Cost Estimation, etc.

Structural Code	Tender Stage Volume	Design Stage Volume	Difference
Pile Cap	228.18	278.12	49.94
Pile	602.84	712.23	109.39
Pier Cap	261.66	320.72	59.06
Pier	181.95	177.04	-4.91
Superstructure	1320.89	1412.22	91.33
Total	**2595.52**	**2900.33**	**304.81**

Tender v/s Design Comparison

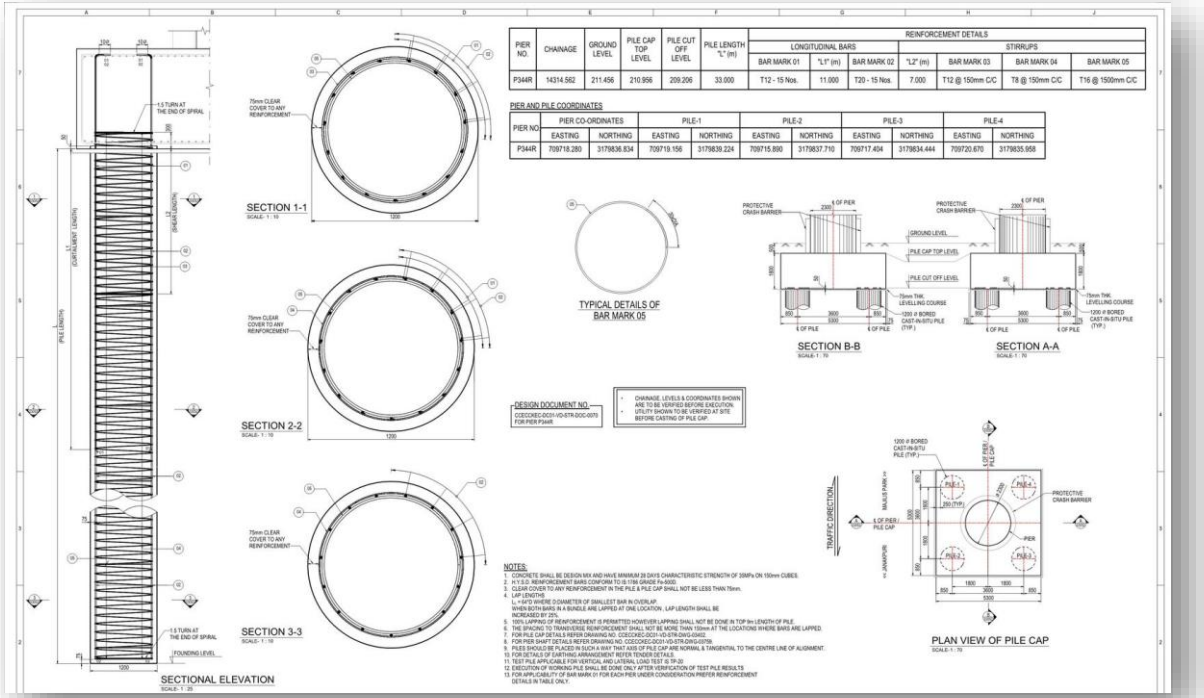
Sr No.	Structural Code	Concrete Type	Tender Stage Volume	Design Stage Volume				Total Design Volume	Difference
				M15	M35	M40	M50	M60	
1	Pile	Cast in Situ	1928.34	-	3334.31	-	-	-	3334.31	1405.97
2	Pile Cap	Cast in Situ	873.52	-	2031.98	-	-	-	2031.98	1158.46
3	Pier	Cast in Situ	653.8	-	-	-	518.62	-	518.62	-135.18
4	RCC Column	Cast in Situ	70.43	-	-	-	14.43	-	14.43	-56
5	Structural Framing	Cast in Situ	3002.55	-	-	-	67.9	279.8	347.7	1017.16
6	Structural Framing	Pre-cast		-	-	-	985.35	2686.66	3672.01	
7	RCC Slab	Cast in Situ	1356.74	-	-	523.89	-	-	523.9	-821.08
8	RCC Slab	Pre-cast		-	11.76	-	-	-	11.76	
9	PCC Slab	Cast in Situ	34.21	74.23	-	-	-	-	74.23	40.02
10	RCC Wall	Cast in Situ	315.13	-	-	96.28	-	17.94	114.22	-200.91
11	RCC Staircase	Cast in Situ	66.45	-	-	51.08	-	-	51.08	-15.37
12	Foundation Rebar	Cast in Situ	-	-	-	-	-	-	520239.64 kg	-
-	**Total**	**-**	**8301.17**	**74.23**	**5378.05**	**671.25**	**1586.3**	**2984.4**	**10694.24**	**2393.07**

Creation of Sheets



The models were used to generate the CRD and GFC Drawings for the station and viaduct portions.

Creation of Sheets



PIER NO.	CHAINAGE	GROUND LEVEL	PILE CAP TOP LEVEL	PILE CUT OFF LEVEL	PILE LENGTH "L" (m)	REINFORCEMENT DETAILS						
						LONGITUDINAL BARS				STIRRUPS		
						BAR MARK 01	"L1" (m)	BAR MARK 02	"L2" (m)	BAR MARK 03	BAR MARK 04	BAR MARK 05
P344R	14314.562	211.456	210.956	209.206	33.000	T12 - 15 Nos.	11.000	T20 - 15 Nos.	7.000	T12 @ 150mm C/C	T8 @ 150mm C/C	T16 @ 1500mm C/C

PIER AND PILE COORDINATES

PIER NO.	PIER CO-ORDINATES		PILE-1		PILE-2		PILE-3		PILE-4	
	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING
P344R	709718.280	3179836.834	709719.156	3179839.224	709715.890	3179837.710	709717.404	3179834.444	709720.670	3179835.958

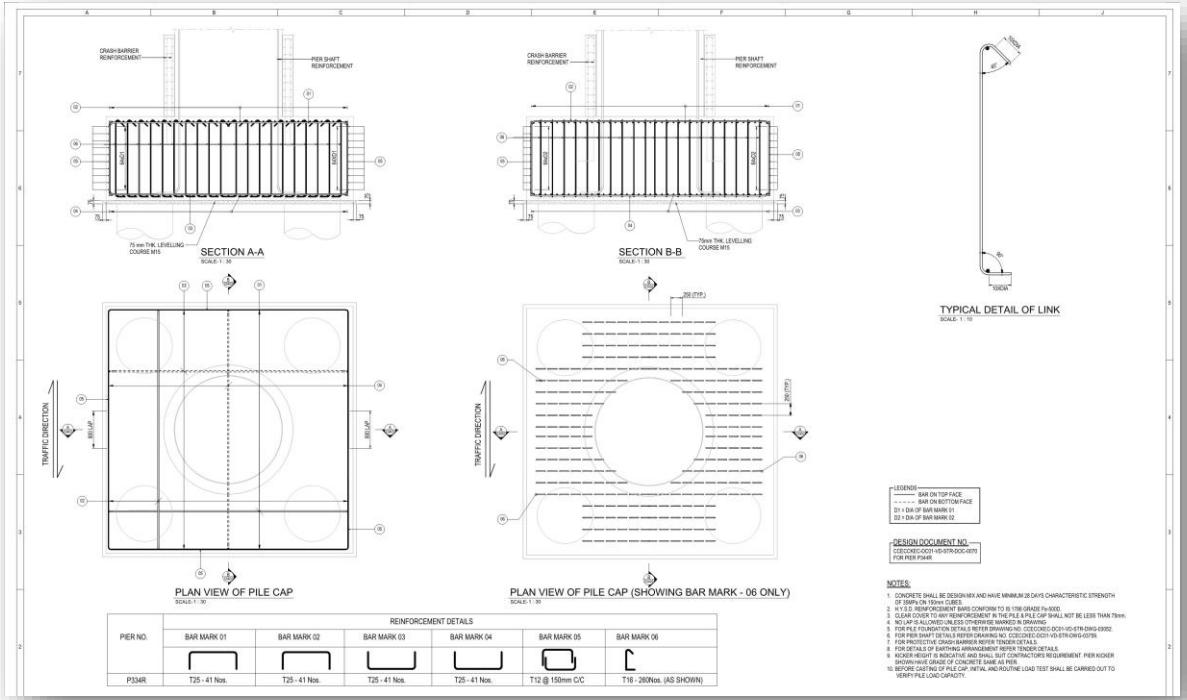
DESIGN DOCUMENT NO.
CCECOREC-DC01-VD-STR-DOC-0070
FOR PIER P344R

- CHAINAGE, LEVELS & COORDINATES SHOWN ARE TO BE VERIFIED BEFORE EXECUTION.
- UTILITY SHOWN TO BE VERIFIED AT SITE BEFORE CASTING OF PILE CAP.

1. CONCRETE SHALL BE DESIGN MIX AND HAVE MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 35MPa ON 150mm CUBES.
2. H.Y.S.D. REINFORCEMENT BARS CONFORM TO IS:1786 GRADE Fe-500D.
3. CLEAR COVER TO ANY REINFORCEMENT IN THE PILE & PILE CAP SHALL NOT BE LESS THAN 75mm.
4. LAP LENGTHS
   L_s = 64*D WHERE D-DIAMETER OF SMALLEST BAR IN OVERLAP.
   WHEN BOTH BARS IN A BUNDLE ARE LAPPED AT ONE LOCATION , LAP LENGTH SHALL BE INCREASED BY 25%.
5. 100% LAPPING OF REINFORCEMENT IS PERMITTED HOWEVER LAPPING SHALL NOT BE DONE IN TOP 9m LENGTH OF PILE.
6. THE SPACING TO TRANSVERSE REINFORCEMENT SHALL NOT BE MORE THAN 150mm AT THE LOCATIONS WHERE BARS ARE LAPPED.
7. FOR PILE CAP DETAILS REFER DRAWING NO. CCECOREC-DC01-VD-STR-DWG-0402.
8. FOR PIER SHAFT DETAILS REFER DRAWING NO. CCECOREC-DC01-VD-STR-DWG-0379.
9. PILES SHOULD BE PLACED IN SUCH A WAY THAT AXIS OF PILE CAP ARE NORMAL & TANGENTIAL TO THE CENTRE LINE OF ALIGNMENT.
10. FOR DETAILS OF EARTHING ARRANGEMENT REFER TENDER DETAILS.
11. TEST PILE APPLICABLE FOR VERTICAL AND LATERAL LOAD TEST @ TP-20
12. EXECUTION OF WORKING PILE SHALL BE DONE ONLY AFTER VERIFICATION OF TEST PILE RESULTS
13. FOR APPLICABILITY OF BAR MARK 01 FOR EACH PIER UNDER CONSIDERATION PREFER REINFORCEMENT DETAILS IN TABLE ONLY.

The drawings include details for Concrete details as well as Reinforcement details.

Creation of Sheets



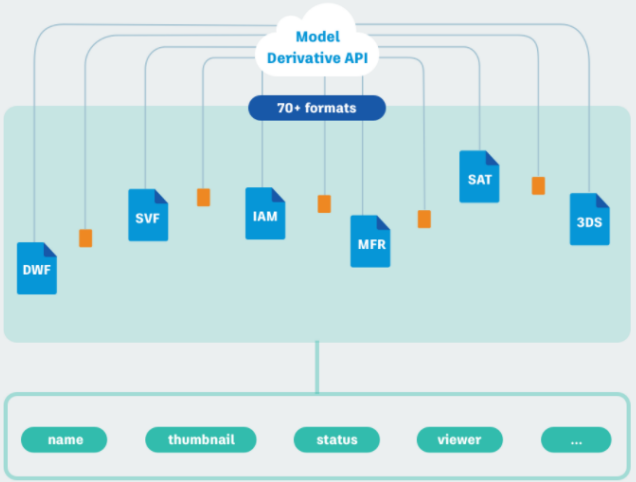
The drawings were created after coordinating all the elements within the model to provide the site team with accurate details and avoid issues during construction

What is Forge?

Forge is a cloud-based developer platform from Autodesk. The Forge Platform offers APIs and services that help you access and use your design and engineering data via the cloud.

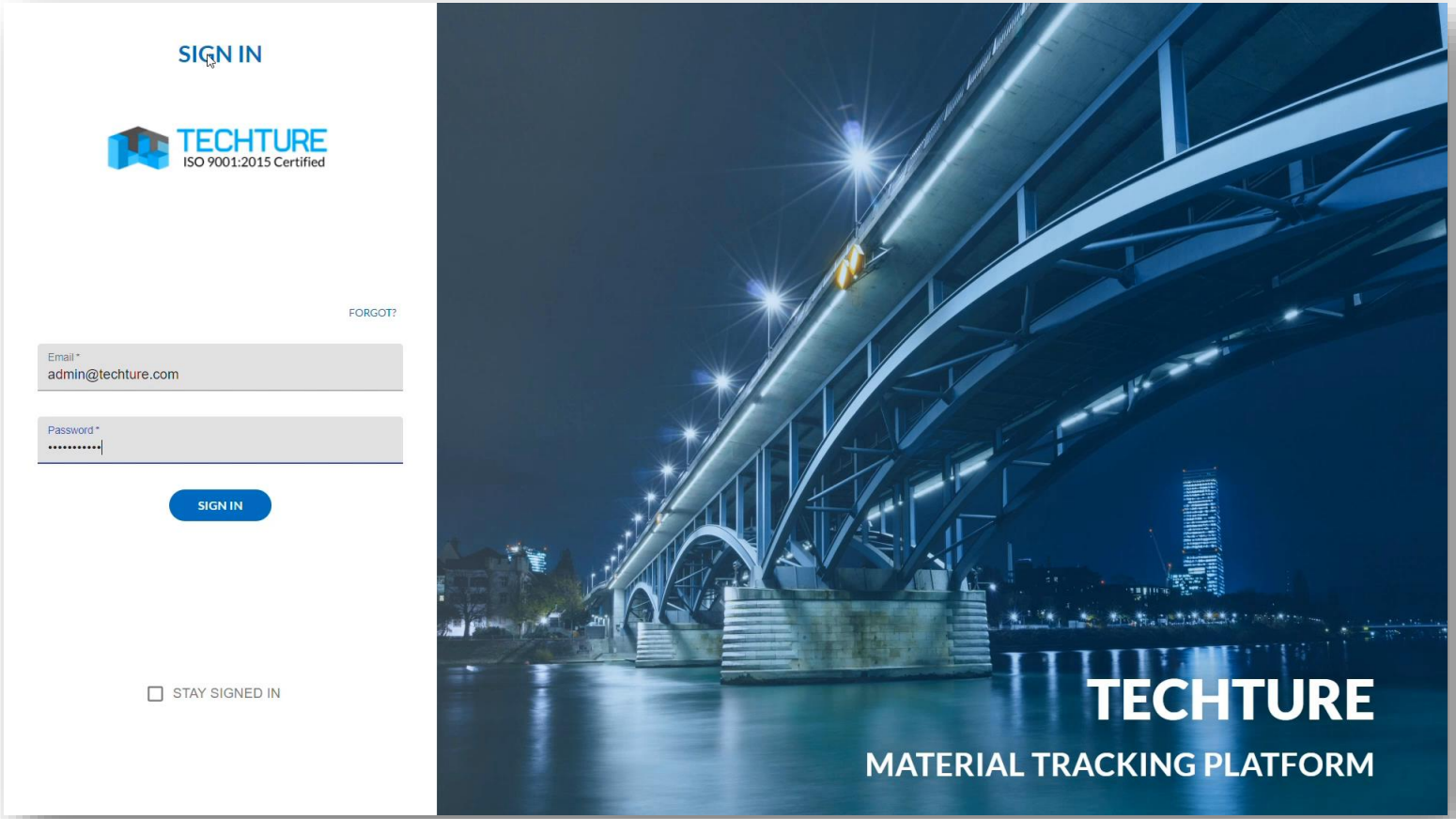
- BIM 360 API
- Data Management API
- Model Derivative API
- Design Automation API
- Authentication API
- Viewer API
- Reality Capture API
- Token Flex API
- Webhooks

Model Derivative API

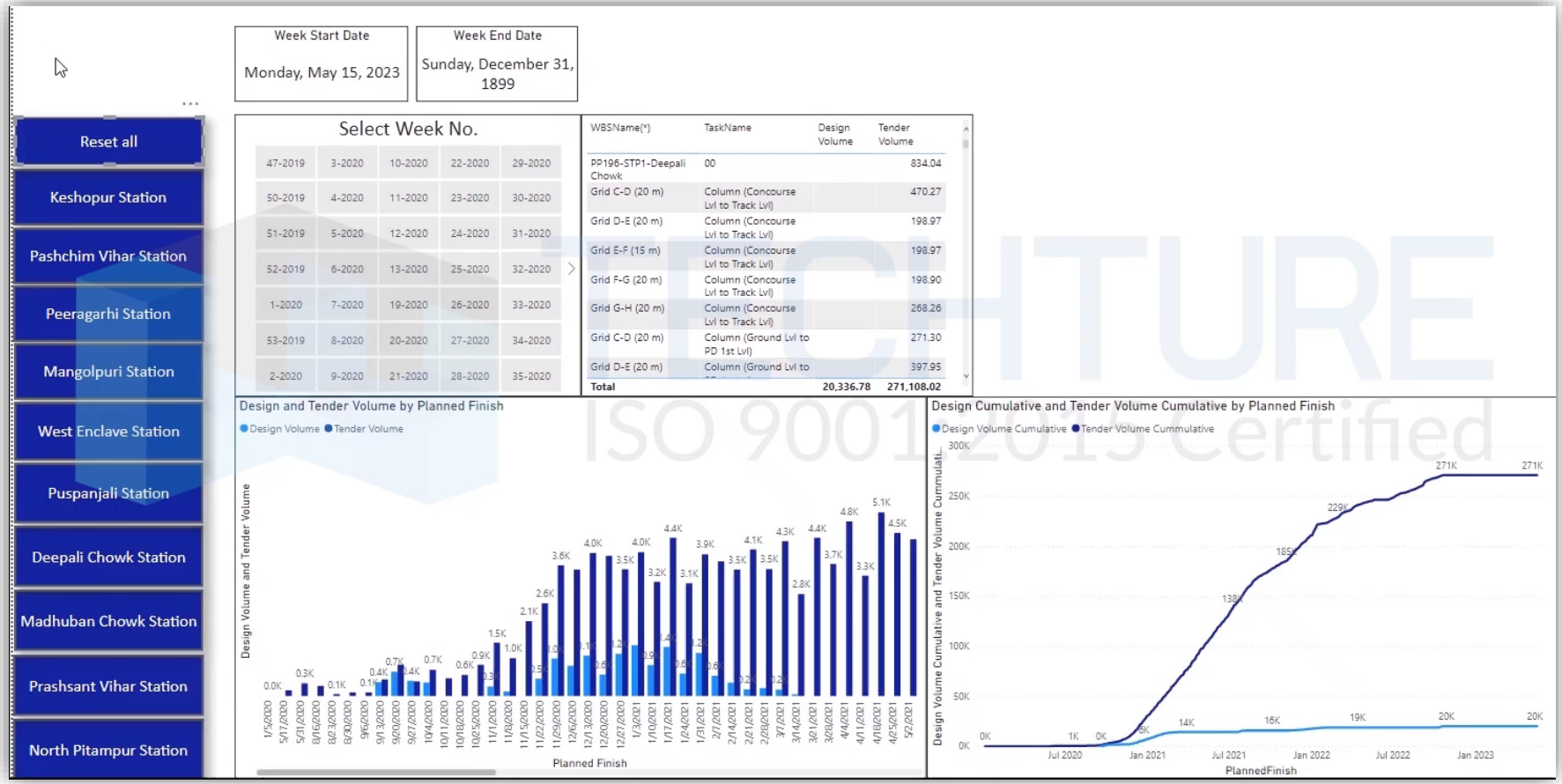


- **This API can be used to prepare designs for rendering in the Viewer**
- **It can also be used to convert design files into other formats**

Forge based Customization



Dashboard Generation



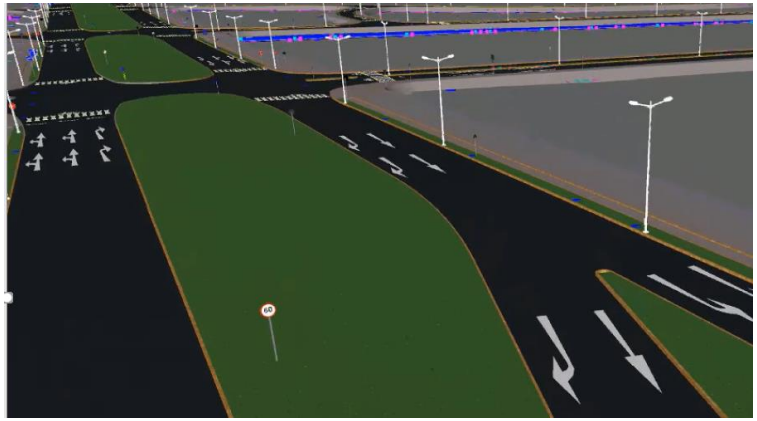
BIM for Highway Infrastructure Projects with the help of **Autodesk** tools

Case Study – Bidkin Industrial City & Expressways

Benefits

- Improved coordination in design & Clash detection
- Quantity Extraction , cost estimation and report management
- 4D, 5D BIM, Improved Scheduling & Sequencing
- Improved Execution, productivity and Saving in resources
- Preconstruction Project Visualization
- Digital Documentation and Common Data Environment
- Coordinated and Shop drawings generation

Highway & Roads BIM Modelling



Civil 3D

Infraworks

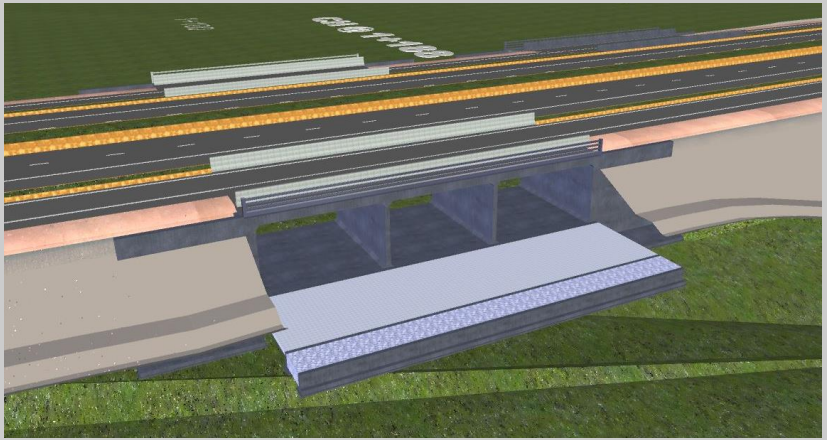
Highways & Utilities – Modelling Process

Structure Model:- The design drawing prepared by design consultant is basically a 2D AutoCAD drawing. The data rich 3D BIM model of the structures across the road is prepared with reference to design drawing and placed at designed elevation at its original location on road.

With this process we will get an idea about the level issues, clashes between the components etc. We can extract the shop drawings from the 3D BIM model which will be used in onsite construction.

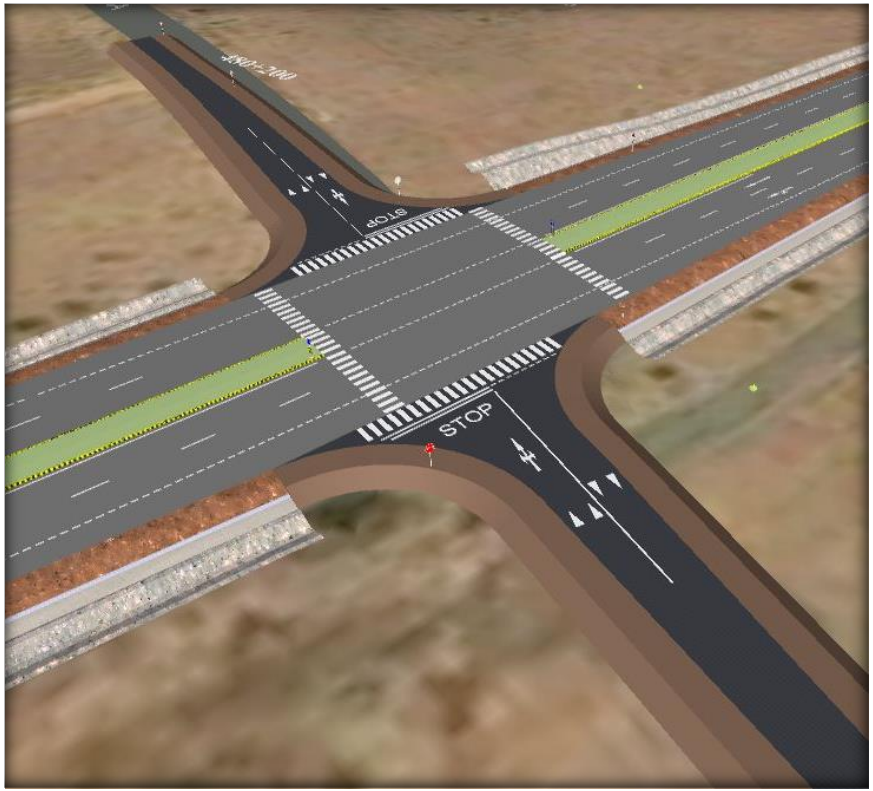
Highway Model:- Using the Plan & profile and other design drawing of highways , highway model reflecting the design highway geometry and other elements like road furniture , l junctions etc can be created.

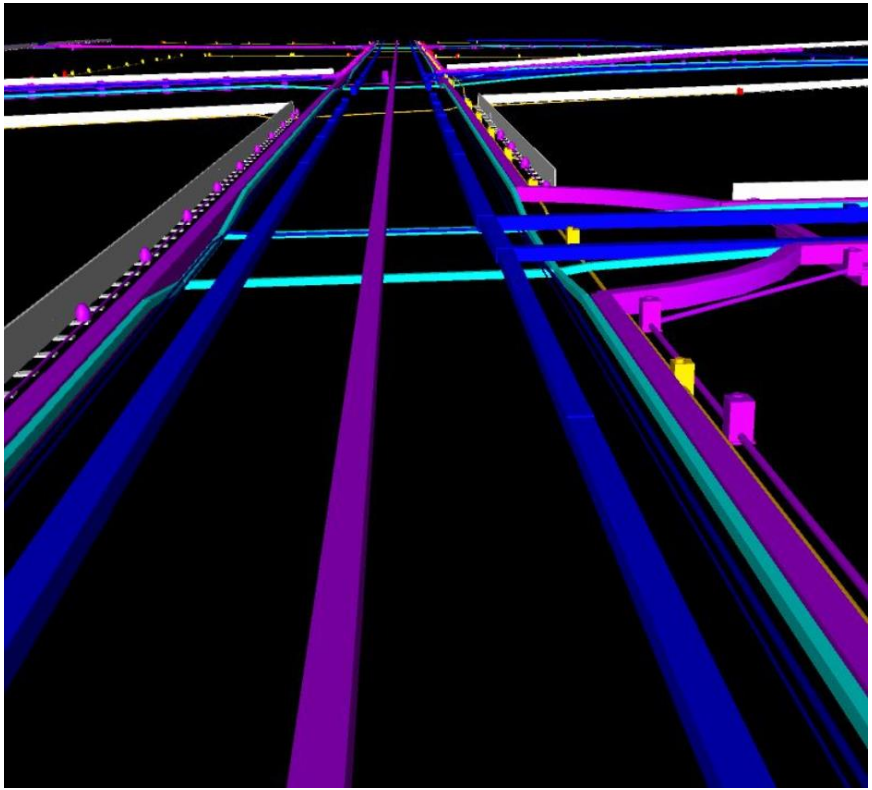
We can get the quantities, shop drawing, 4D/5D BIM model generation etc from the model. By combining road and structure model client and designers can get better visualization and it helps stakeholders in decision making process.



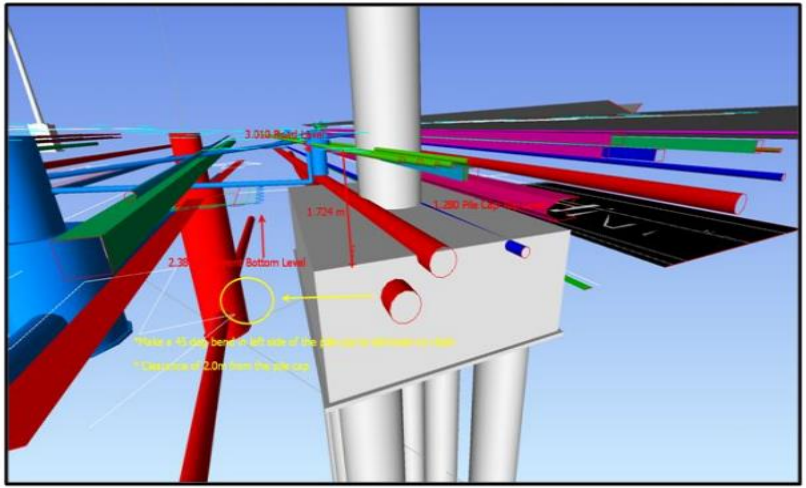
BIM for Highways & utilities

Exported Samples

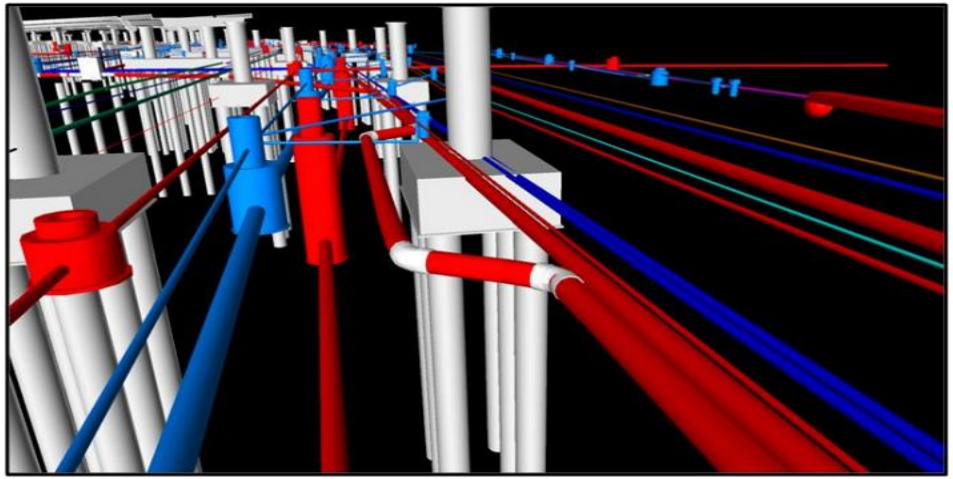




Spatial Coordination & Clash Resolution

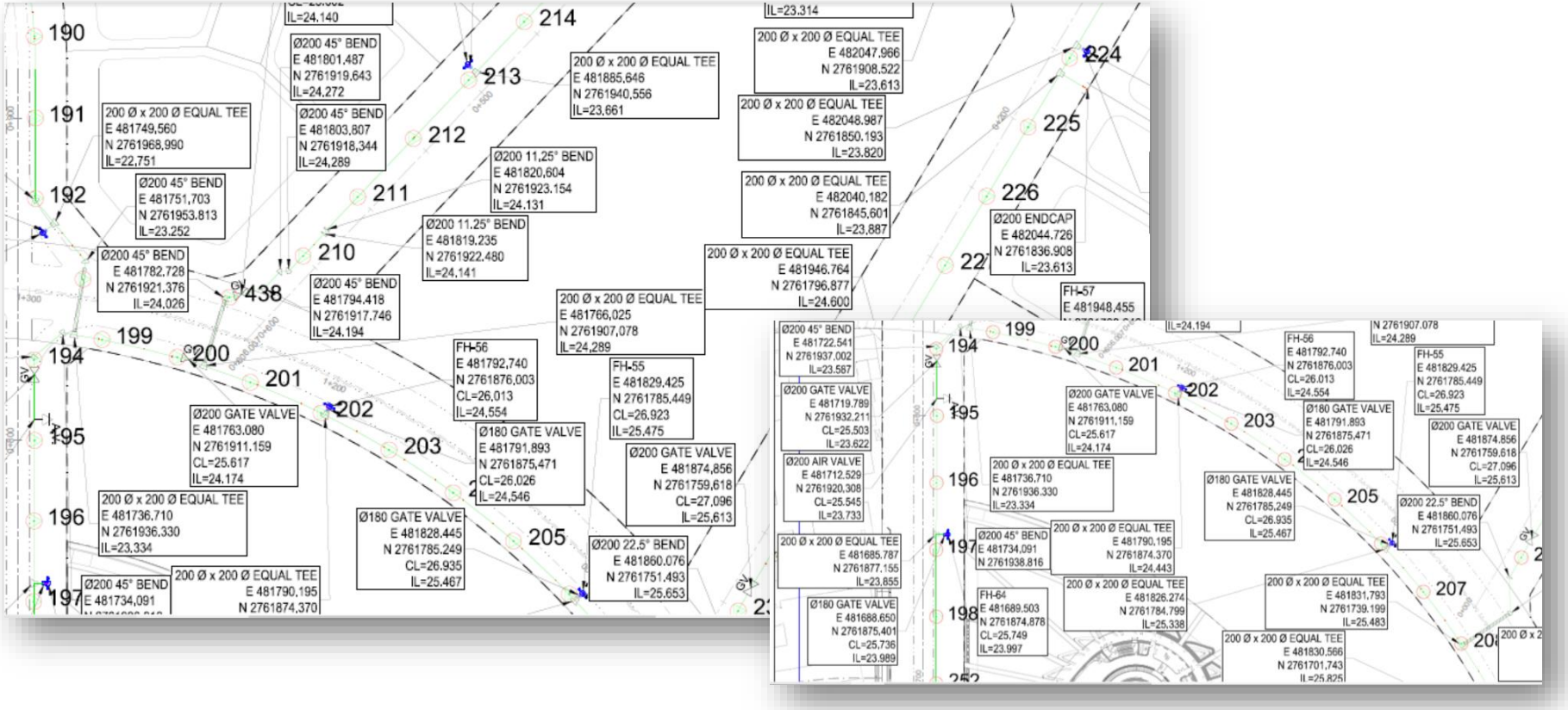


Original Model as per IFC Drawings



Revised Clash Free Model after Technical Discussions

Use of Civil 3D for Drawings Generation



Highway & Roads BIM Modelling

Quantity Estimation

Pipe Table

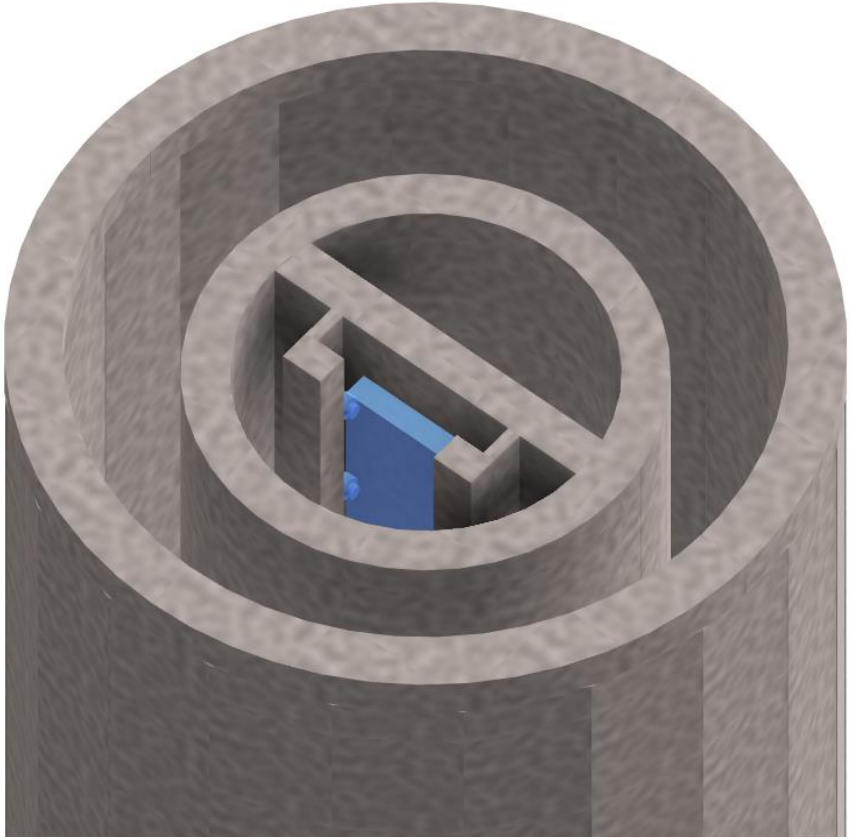
NAME	SIZE	LENGTH	SLOPE	MATERIAL	START STRUCTURE	END STRUCTURE	PIPE INVERT IEVEL
Pipe – (9)	1800 mm	304.3 m	0.12%	RCC PIPE with HDPE lining	MH–8	MH–16	SIL – 97.985 EIL – 97.605
Pipe – (2)	1800 mm	129.7 m	0.37%	RCC PIPE with HDPE lining	MH–16	MH–17	SIL – 97.605 EIL – 97.130
Pipe – (3)	2100 mm	48.4 m	0.08%	RCC PIPE with HDPE lining	MH–17	MH–18	SIL – 97.130 EIL – 97.090
Pipe – (4)	2100 mm	261.9 m	0.08%	RCC PIPE with HDPE lining	MH–18	MH–19	SIL – 97.090 EIL – 96.872
Pipe – (5)	2100 mm	235.3 m	0.08%	RCC PIPE with HDPE lining	MH–19	MH–20	SIL – 96.872 EIL – 96.676
Pipe – (8)	2100 mm	340.0 m	0.08%	RCC PIPE with HDPE lining	MH–20	MH–21	SIL – 96.676 EIL – 96.393
Pipe – (7)	2100 mm	89.0 m	0.00%	RCC PIPE with HDPE lining	MH–21		SIL – 96.393 EIL – 96.393

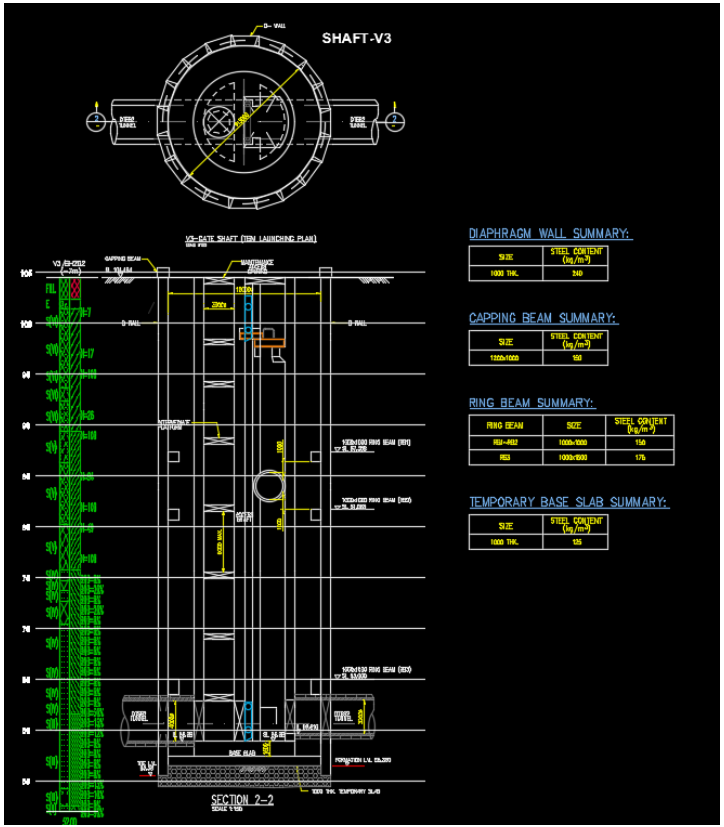
STRUCTURE TABLE

STRUCTURE NAME:	DETAILS:
MH–8	E = 19846.5260 N = 35811.6580 RIM = 115.90 m SUMP = 97.83 m RIM to SUMP HEIGHT = 18.075 m
MH–16	E = 19904.7512 N = 35513.0003 RIM = 112.49 m SUMP = 97.44 m RIM to SUMP HEIGHT = 15.046 m
MH–20	E = 19776.8650 N = 34872.8910 RIM = 109.32 m SUMP = 96.49 m RIM to SUMP HEIGHT = 12.829 m
MH–17	E = 19880.9070 N = 35385.5380 RIM = 109.18 m SUMP = 97.13 m RIM to SUMP HEIGHT = 12.051 m
MH–18	E = 19890.5719 N = 35338.1372 RIM = 108.21 m SUMP = 96.90 m RIM to SUMP HEIGHT = 11.305 m
MH–21	E = 19606.4477 N = 34580.3792 RIM = 107.87 m SUMP = 96.21 m RIM to SUMP HEIGHT = 11.662 m
MH–19	E = 19765.7930 N = 35107.8990 RIM = 106.84 m SUMP = 96.69 m RIM to SUMP HEIGHT = 10.153 m

- 3D model can be used to create quantity estimation outputs in the form of tables which can be exported or displayed on drawing sheets (DWG/PDF files)
- Can be customized to suit any standards
- Data directly linked to the 3D model and updates continuously as changes are made

UTILITY STRUCTURES





Model and Sheet Automation - Dynamo

Objectives & Challenges

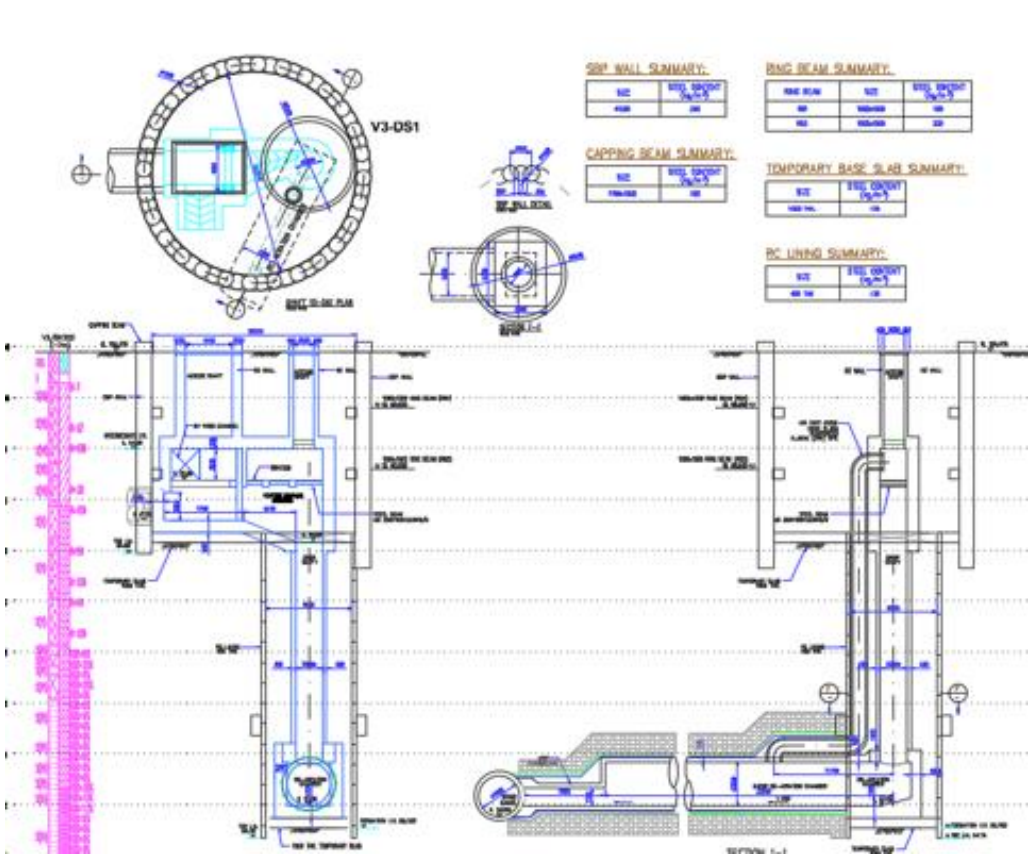
- Infrastructure modelling tools like Civil 3D etc. don’t support higher LOD of manholes, especially to detail parts, rebar, piping connections etc. That is possible in a tool like Revit.

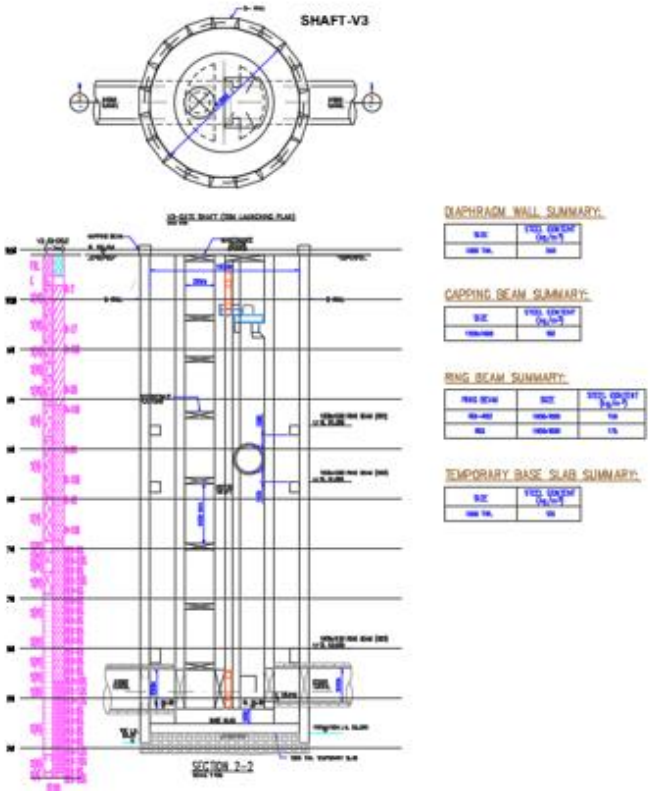
- However, in Revit, the major challenge is to place the manholes at the correct coordinates and also with the right orientation, and the pipes at correct invert levels. This is solved using a combination of a complex parametric family and Dynamo to drive the parameters.

- Dynamo scripts helped automate placement of the manholes, as well as generate shop drawings of the same.

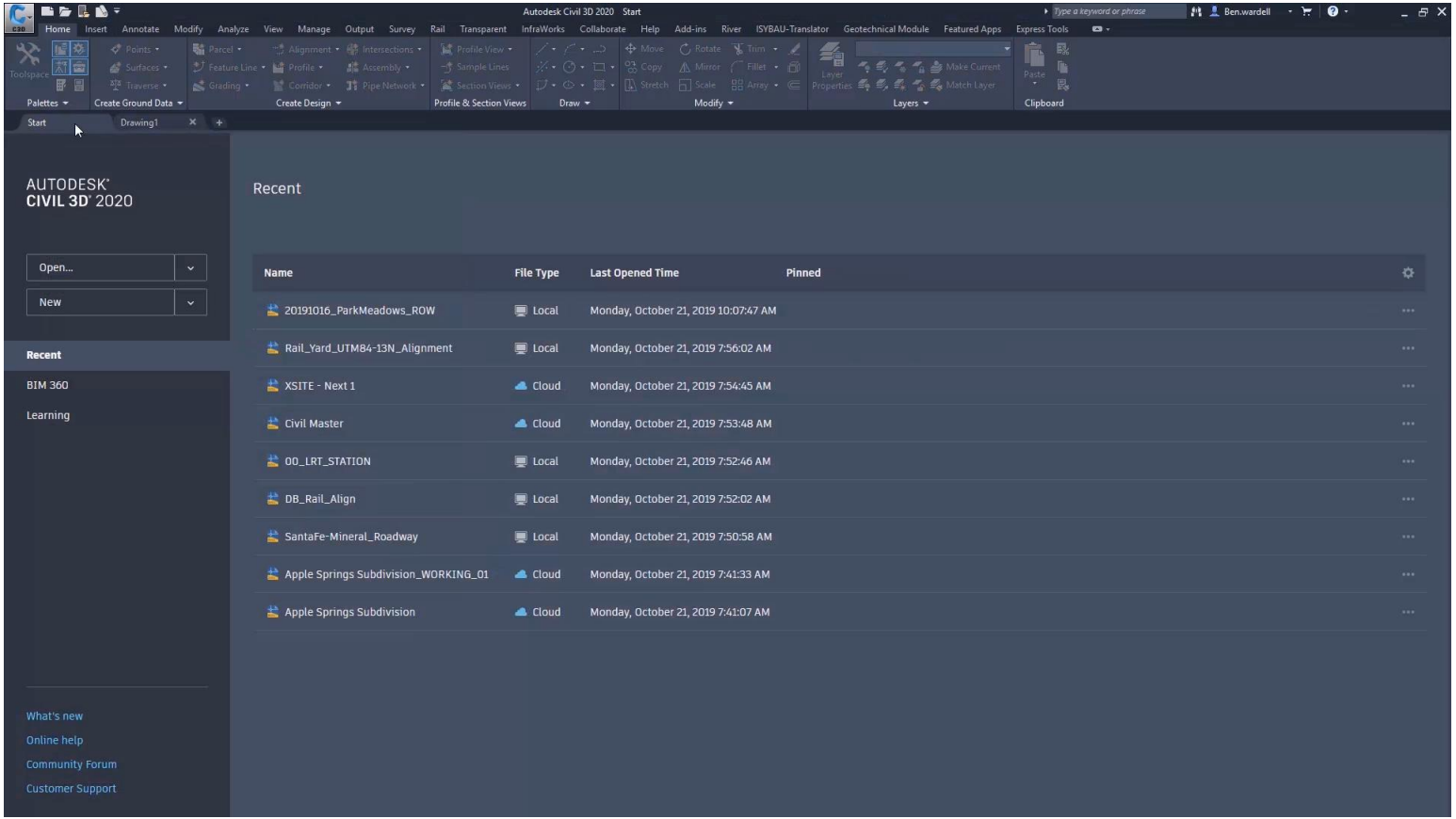
Model and Sheet Automation - Dynamo

Creation of Shop Drawings





Collaboration using BIM Collaborate Pro - ACC

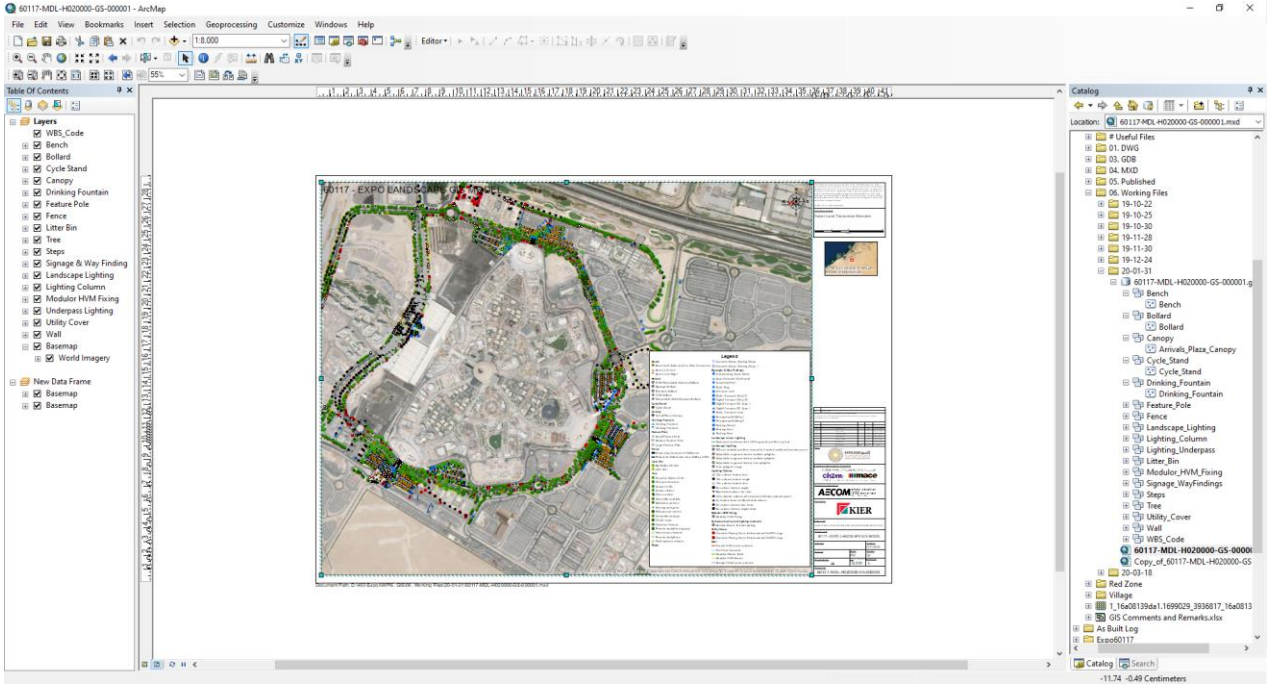


Courtesy: Autodesk

BIM & GIS Integration

- The Integration of the BIM Model, as seen for Roads, Water Tank and Street Furniture has happened with the GIS Imagery and the Digital Elevation Model

- The Platform for Integration as used here Autodesk Infraworks and ArcGIS.



Summary

- Although infrastructure projects in India have not utilized Autodesk tools to their potential, there is a lot to explore.
- Autodesk tools already have robust capabilities to deliver Infra projects including linear infrastructure, rail, metro, water utilities and highways.
- Enhanced tools for Rebar modelling make it possible to deliver highly detailed BIM Models and related sheets.
- Need to think out of the box to create practical workflows utilizing Revit, Civil 3D and Infraworks and extend the possibilities using tools like Dynamo
- Using cloud-based tools like BIM Collaborate Pro (for Revit as well as Civil 3D) and other offerings within Autodesk Construction Cloud collaboration is eased and tailor-made solutions can be built using Forge.

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