

BES500178

Workflows to develop, manage & integrate Infrastructure BIM Projects

Viraj Voditel

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Director | @dayeshjaiswal

About the speakers



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



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AU SPEAKER 2017



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@techtute.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

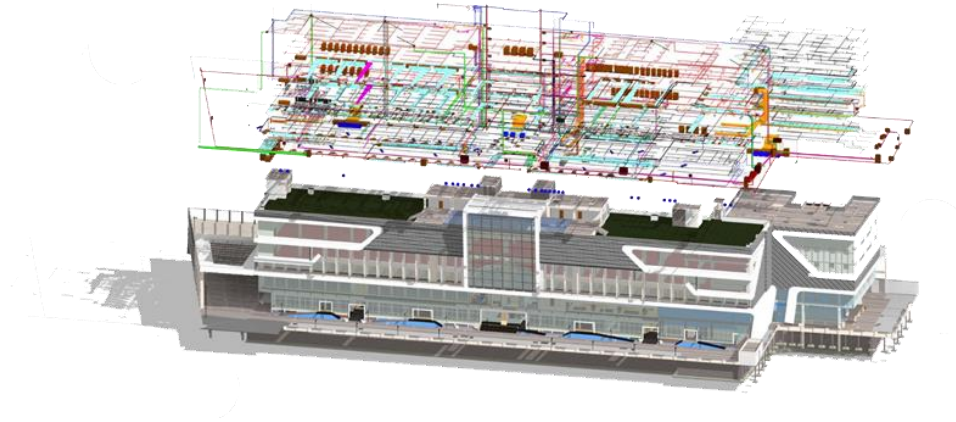
LEARNING OBJECTIVE 3

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

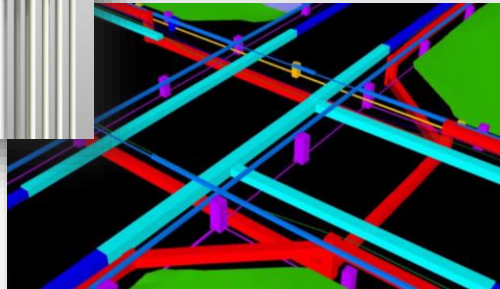
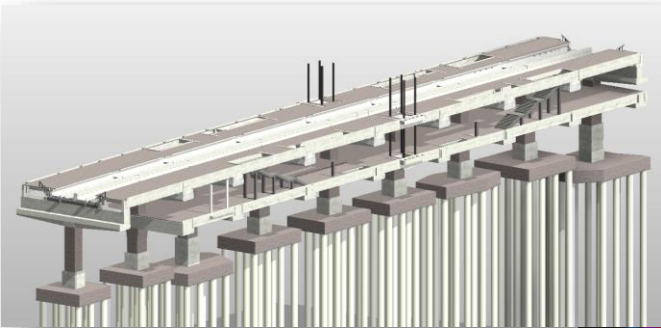
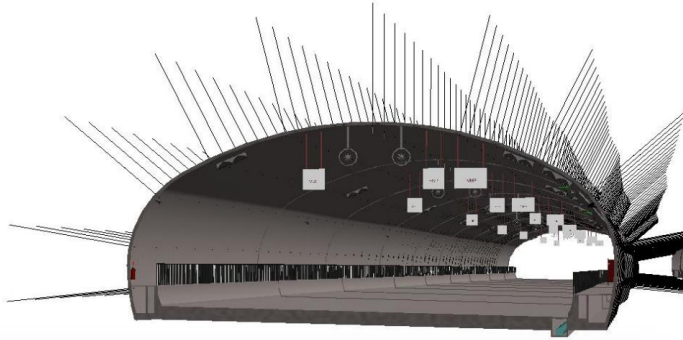


- Buildings specific BIM workflows have been well defined and documented over the years.
- The level of detail, information, definitions and 3D modelling tools have matured and are readily available.
- Various case studies published for 3D to 4D/5D/6D/7D workflows.
- The infrastructure sector still isn't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

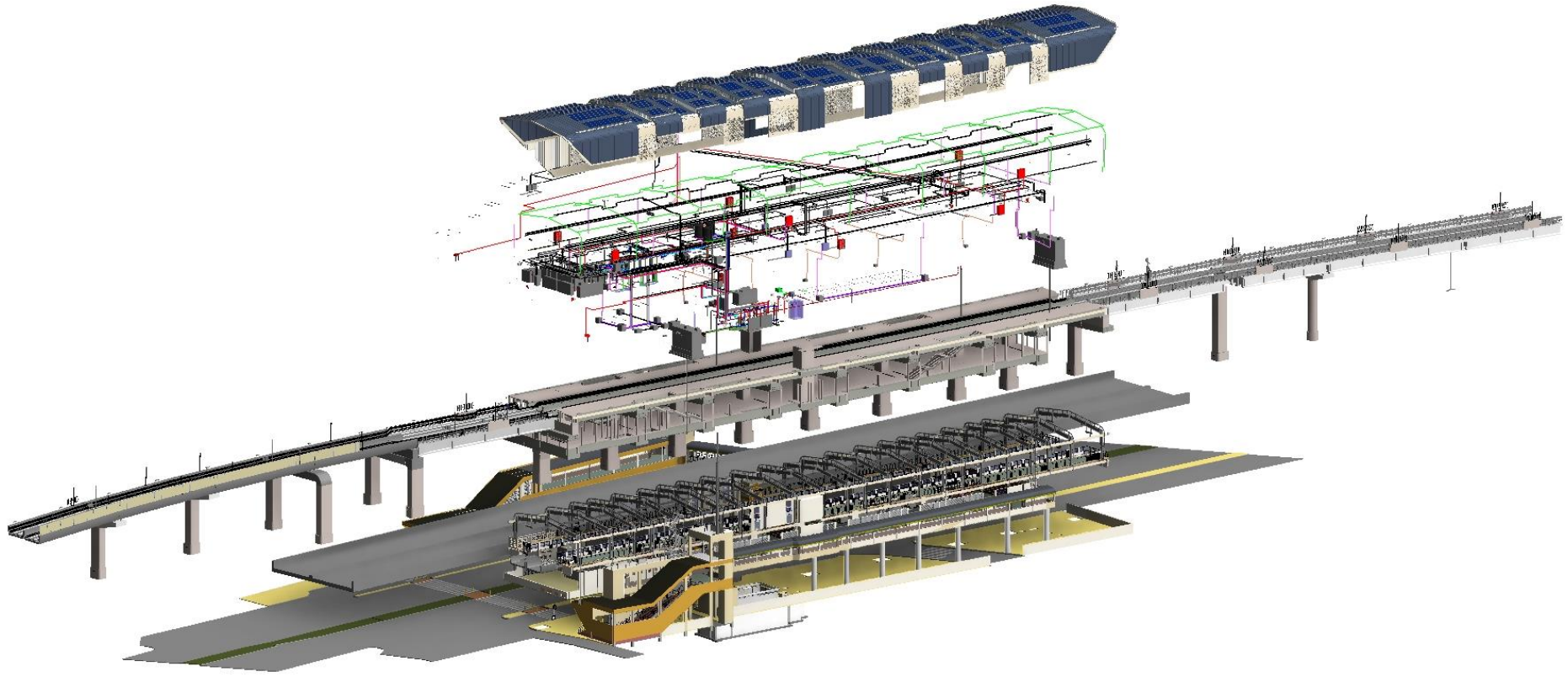


We will look at some case studies from large Indian construction projects where **Autodesk** tools were successfully utilized.

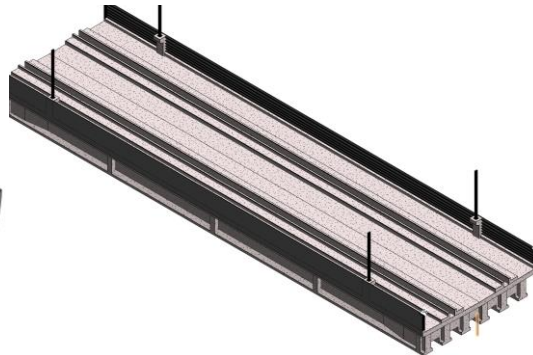
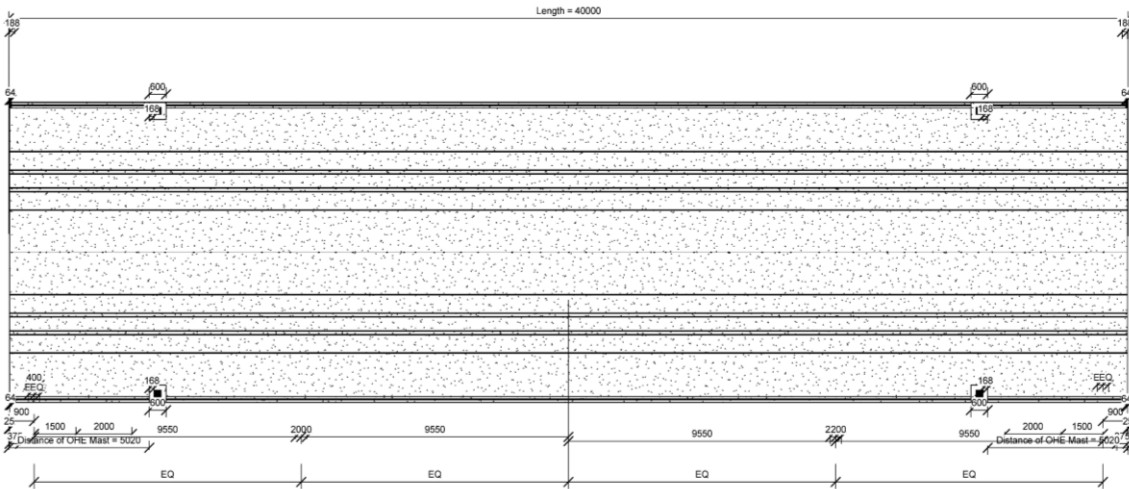
Case Study - Delhi Metro

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

Scale – 12.5 km Viaduct & 10 Elevated stations



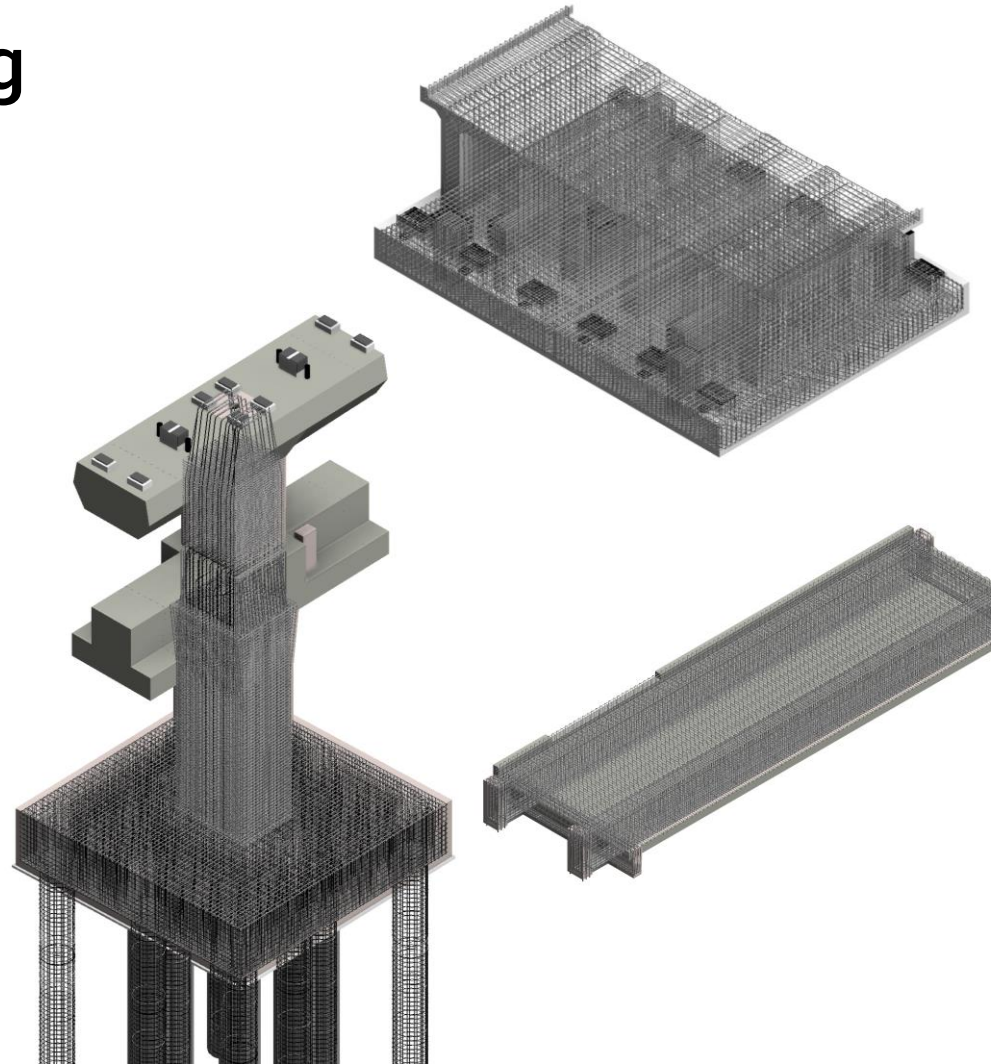
Creating Complex Parametric Families



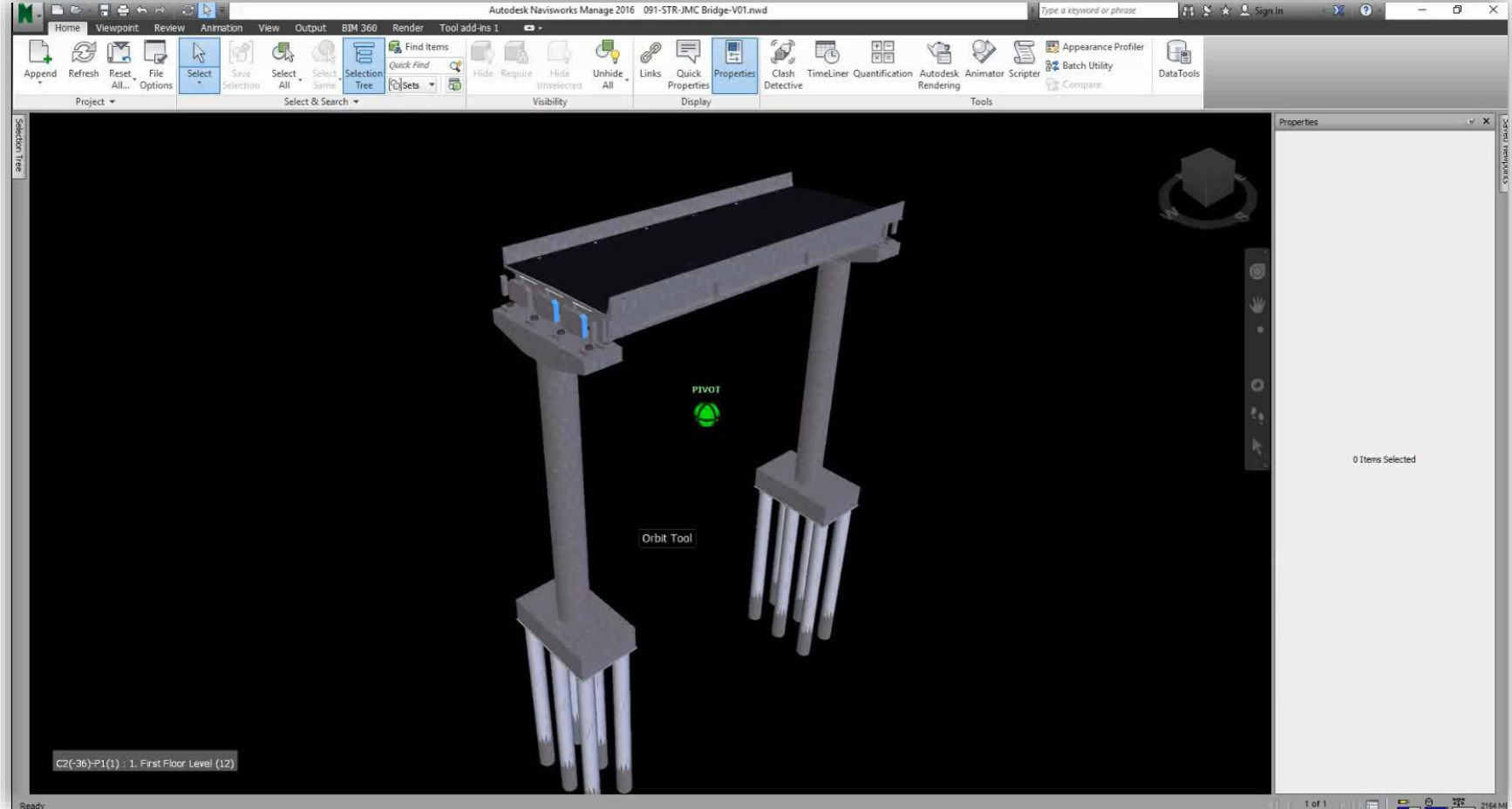
- Customized Parametric families were created in this project for elements like Viaduct U-Girder, T-Girder, Pi-Girders, etc.
- The main challenge was to define the length, angle of curvature, openings for lifting holes, shear block cut outs, drain pipe cutout, bearing locations, cable tray hangers, etc.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

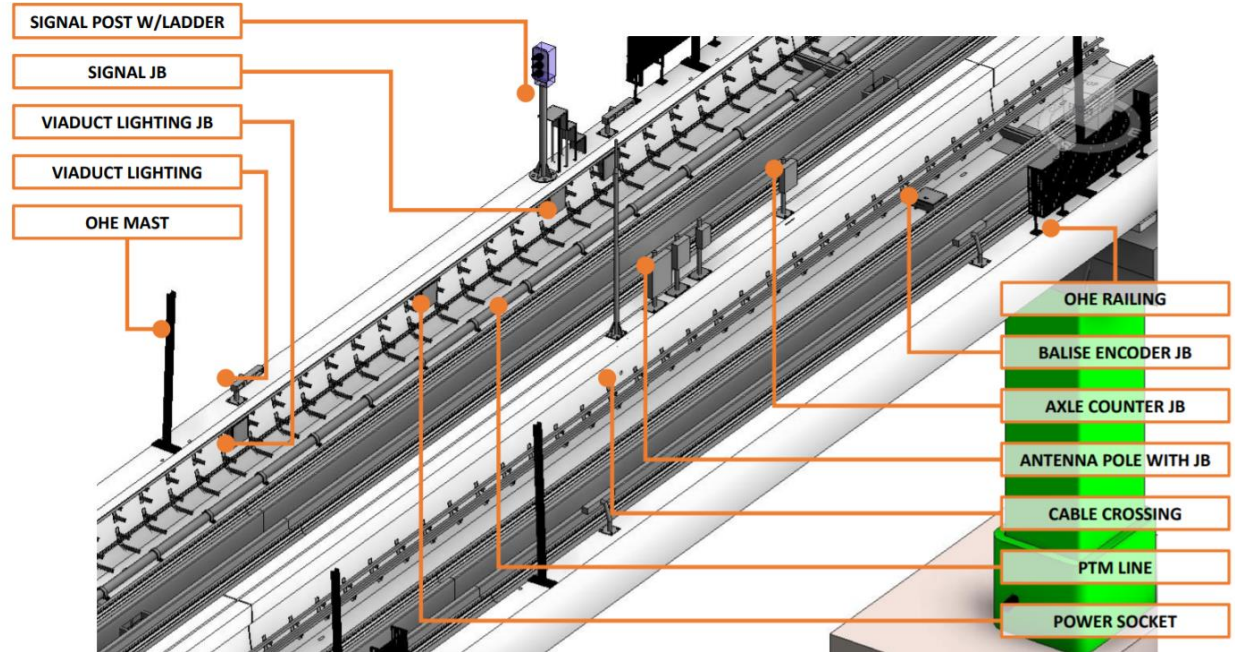


Reinforcement Modelling



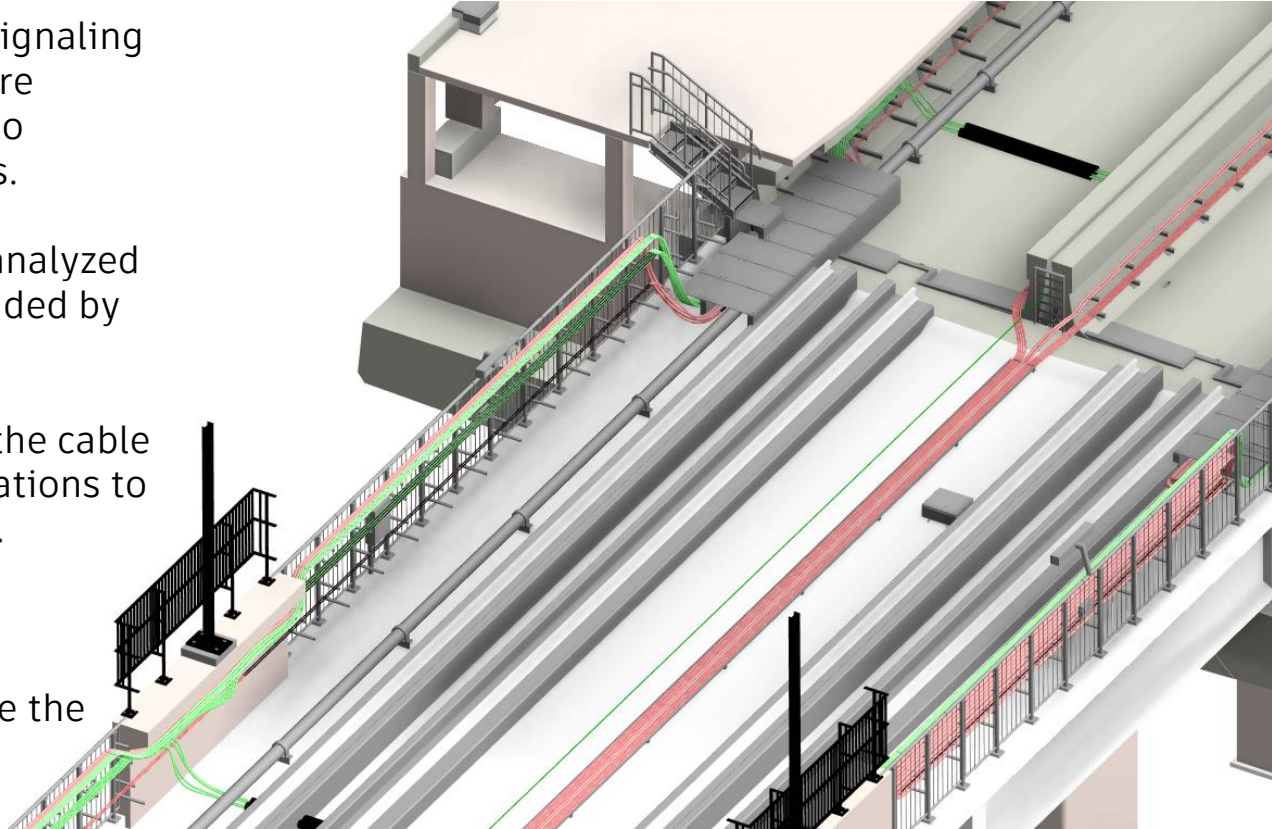
Signaling & Telecommunication Modelling

- 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

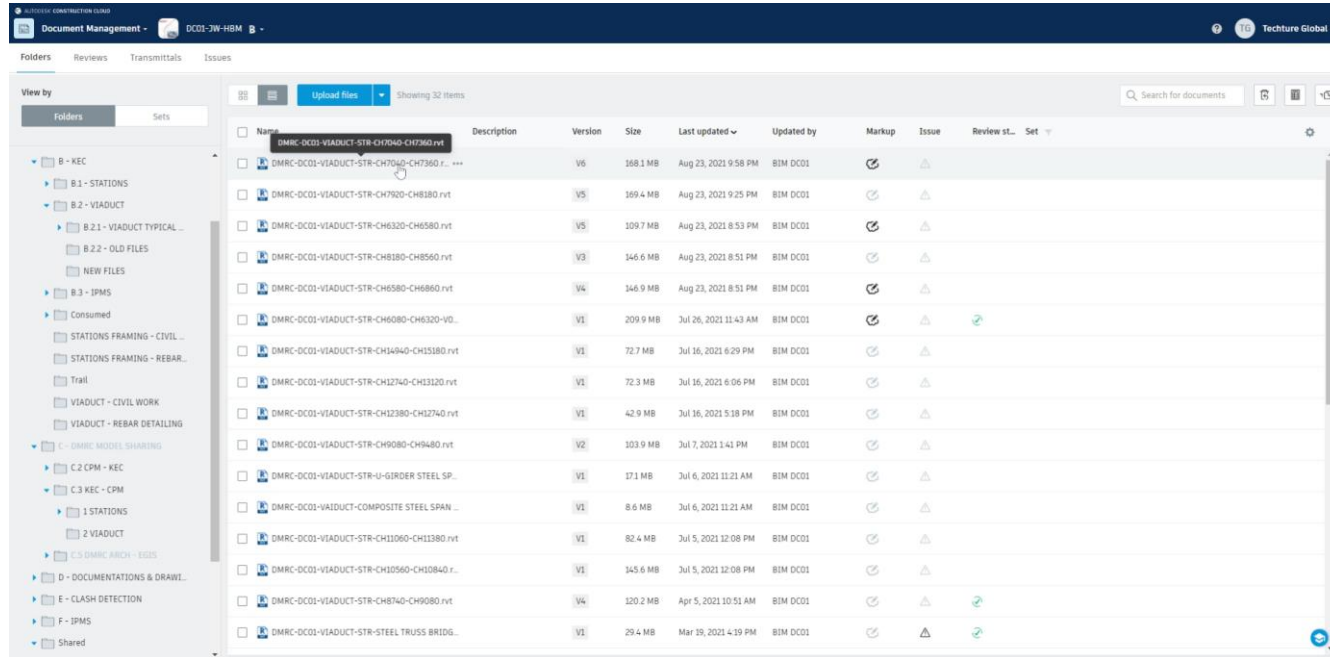
- Equipment and cables for Signaling and Telecommunication were modelled over the viaduct to represent the S&T elements.
- This model is then further analyzed to validate the design provided by the consultants.
- It was also used to design the cable routing at the interface locations to check for space 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.



The screenshot displays the BIM360 Document Management interface. The top navigation bar includes 'Document Management' and 'DC01-JW-HBM'. The left sidebar shows a hierarchical folder structure under 'B - KEC', including 'B.1 - STATIONS', 'B.2 - VIADUCT', 'B.2.1 - VIADUCT TYPICAL ...', 'B.2.2 - OLD FILES', 'NEW FILES', 'B.3 - IPMS', 'Consumed', 'STATIONS FRAMING - CIVIL ...', 'STATIONS FRAMING - REBAR ...', 'Trail', 'VIADUCT - CIVIL WORK', 'VIADUCT - REBAR DETAILING', 'C - DMRC MODEL SHARING', 'C.2 CPM - KEC', 'C.3 KEC - CPM', '1 STATIONS', '2 VIADUCT', 'C.5 DMRC ARCH - EGGS', 'D - DOCUMENTATIONS & DRAW...', 'E - CLASH DETECTION', 'F - IPMS', and 'Shared'.

The main content area shows a list of documents. The table has columns: Name, Description, Version, Size, Last updated, Updated by, Markup, Issue, Review st., and Set. The first document is 'DMRC-DC01-VIADUCT-STR-CH7060-CH7360.rvt' with version V6, size 168.1 MB, last updated on Aug 23, 2021 at 9:58 PM, updated by BIM DC01, and marked as 'Issue'.

Name	Description	Version	Size	Last updated	Updated by	Markup	Issue	Review st.	Set
DMRC-DC01-VIADUCT-STR-CH7060-CH7360.rvt		V6	168.1 MB	Aug 23, 2021 9:58 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH7060-CH7360.rvt		V5	169.4 MB	Aug 23, 2021 9:25 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH6320-CH6580.rvt		V5	109.7 MB	Aug 23, 2021 8:53 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH8180-CH8560.rvt		V3	146.6 MB	Aug 23, 2021 8:51 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH6580-CH8660.rvt		V6	146.9 MB	Aug 23, 2021 8:51 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH6080-CH6320-V0...		V1	209.9 MB	Jul 26, 2021 11:43 AM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH14040-CH15180.rvt		V1	72.7 MB	Jul 16, 2021 6:29 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH12740-CH13120.rvt		V1	72.3 MB	Jul 16, 2021 6:06 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH12380-CH12740.rvt		V1	42.9 MB	Jul 16, 2021 5:18 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH9080-CH9480.rvt		V2	103.9 MB	Jul 7, 2021 1:41 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-U-GIRDER STEEL SP...		V1	17.1 MB	Jul 6, 2021 11:21 AM	BIM DC01				
DMRC-DC01-VIADUCT-COMPOSITE STEEL SPAN ...		V1	8.6 MB	Jul 6, 2021 11:21 AM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH1060-CH11380.rvt		V1	82.4 MB	Jul 5, 2021 12:08 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH1060-CH10840.r...		V1	145.6 MB	Jul 5, 2021 12:08 PM	BIM DC01				
DMRC-DC01-VIADUCT-STR-CH8740-CH9080.rvt		V4	120.2 MB	Apr 5, 2021 10:51 AM	BIM DC01				
DMRC-DC01-VIADUCT-STR-STEEL TRUSS BRIDG...		V1	29.4 MB	Mar 19, 2021 4:19 PM	BIM DC01				

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

JANAKPURI

MJALIS JALP

CONCOURSE LEVEL PLAN

SECTION A-A
SCALE: 1 : 50

SECTION B-B
SCALE: 1 : 30

SECTION C-C
SCALE: 1 : 30

SECTION D-D
SCALE: 1 : 50

SECTION E-E
SCALE: 1 : 30

DETAIL-1
SCALE: 1 : 10

DETAIL-2
SCALE: 1 : 20

DETAIL-3
SCALE: 1 : 50

SCHEDULE OF BEAMS - CONCOURSE

BEAM MARKED	WIDTH IN MM	DEPTH IN MM
CB2	300	725
CTB1	500	725
CTB2	500	725
CTB3	300	1475
CTBA	300	1475
CTB4	300	725
CTBA4	300	725
CTB5	300	1475
CTBA5	300	1475
CTB6	200	275
CTB7	300	275
CTB8	400	725

SCHEDULE OF COLUMNS - CONCOURSE

COLUMN MARKED	SIZE OF COLUMN	SHAPE OF COLUMN	REMARKS
MC1	300X450		CONCOURSE MALLION COLUMN
SC1	400X400		CONCOURSE TO STAIRCASE
SC2	450X450		CONCOURSE TO ESCALATOR

NOTES:-

- ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
- DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS IS TO BE FOLLOWED.
- ANY DISCREPANCIES MUST BE BROUGHT TO THE NOTICE OF THE CONSULTANT BEFORE EXECUTION OF WORK AT SITE.
- THE DRAWING SHALL BE READ IN CONJUNCTION WITH RELEVANT ARCHITECTURAL DRAWINGS.
- FOR GENERAL NOTES AND GENERAL DETAILS PLEASE REFER DRAWING NO. BIC-FSTR-001-30001 TO BIC-FSTR-001-30006

LEGENDS :-

- CPG - CONCOURSE PIER GIRDER
- CLB - CONCOURSE LONGITUDINAL BEAM
- CTB - CONCOURSE TRANSVERSE BEAM
- SC - STUD COLUMN
- MC - MALLION COLUMN

ARCHITECTURAL DRAWING REFERENCE:-
EIRAD005-DMRC-FSD-AR-DCI-PW-18100, 18101 & 18102
EIRAD005-DMRC-FSD-AR-DCI-PW-18001, 18002, 18013 & 18217
EIRAD005-DMRC-FSD-AR-DCI-PW-18001, 18002 & 18003

TYPICAL STRUCTURAL DRAWING REFERENCE :-
CONCOURSE CROSS ARMS - BIC-FSTR-001-30001 TO 30003
PLATFORM CROSS ARM GIRDER - BIC-FSTR-001-30001 TO 30123
PLATFORM PIER GIRDER - BIC-FSTR-001-30001 TO 30005
PIER LAYOUT & DETAILS

LEGENDS :-

- CAST IN situ
- PRE-CAST
- SHOWN SLAB

(H) Design Quality Assurance

The responsibility of work done and verification drawings shall remain with the Engineer's name and shall not be used for any other purpose without the written consent of the Engineer.

By Designer		Contractor	
Name	Date	Name	Date
[Signature]	[Date]	[Signature]	[Date]

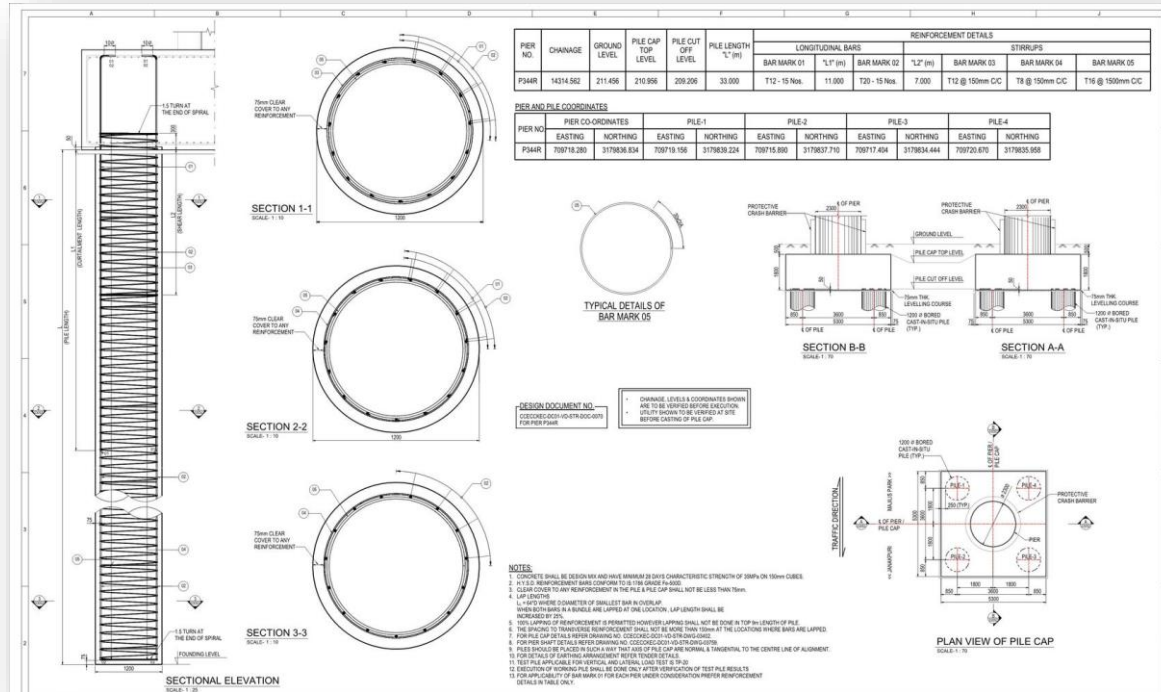
(B) Proof Checker's Certificate :

I hereby certify that the above drawing has been checked and found correct as per the design and specification given by the client.

(C) Notice of No objection from Employer's Representatives

We hereby acknowledge the receipt of the above drawing and find it satisfactory for the execution of the work.

Creation of Sheets



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

SECTION A-A
SCALE 1:30

SECTION B-B
SCALE 1:30

PLAN VIEW OF PILE CAP
SCALE 1:30

PLAN VIEW OF PILE CAP (SHOWING BAR MARK - 06 ONLY)
SCALE 1:30

TYPICAL DETAIL OF LINK
SCALE 1:10

REINFORCEMENT DETAILS

PIER NO.	BAR MARK 01	BAR MARK 02	BAR MARK 03	BAR MARK 04	BAR MARK 05	BAR MARK 06
P34R	T25 - 41 Nos.	T25 - 41 Nos.	T25 - 41 Nos.	T25 - 41 Nos.	T12 @ 150mm CC	T16 - 280 Nos. (AS SHOWN)

LEGEND

- BAR ON TOP FACE
- BAR ON BOTTOM FACE
- 21 - DIA OF BAR MARK 01
- 25 - DIA OF BAR MARK 02

DESIGN DOCUMENT NO.

DESIGNER/REVIEWER/DATE FOR PIER PILES

NOTES

- CONCRETE SHALL BE DESIGN MIX AND HAVE MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 30MPa (28.170mm CUBES).
- IF U.S.S. REINFORCEMENT BARS CONFORM TO IS 1786 GRADE Fe-500.
- CLARIFY TO THE PIER REINFORCEMENT IN THE PILE CAP SHALL NOT BE LESS THAN THAT.
- NO LAP IS ALLOWED UNLESS OTHERWISE MARKED IN DRAWING.
- FOR PILE FOUNDATION DETAILS REFER DRAWING NO. CECED-001-V0-STRONG-0078.
- FOR PROTECTIVE GROUND-BARRIER REFER TENDER DETAILS.
- FOR DETAILS OF EARTHING ARRANGEMENT REFER TENDER DETAILS.
- POUNDER-KEYED IN INDICATING AND SHALL BEET CONTRACTORS REQUIREMENT. PIER-KEYED REFER DRAWING. GRADE OF CONCRETE SHALL BE M20.
- BEFORE CASTING OF PILE CAP, INITIAL AND ROUTINE LOAD TEST SHALL BE CARRIED OUT TO VERIFY PILE CAP CAPACITY.

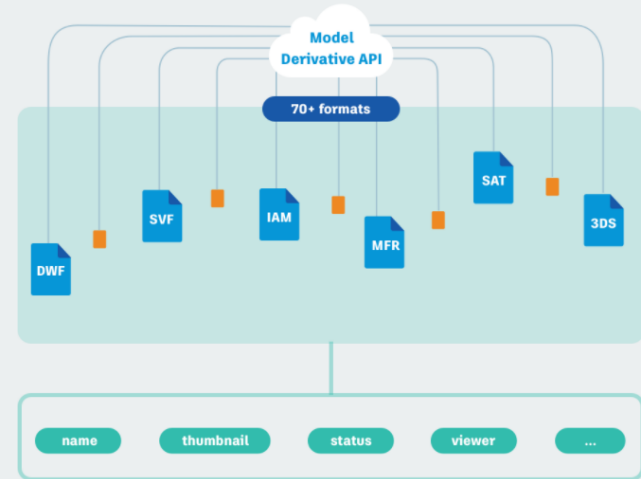
The drawings were created after coordinating all the elements within the model to provide the site team with accurate details and avoid issues during construction

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

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admin@techure.com

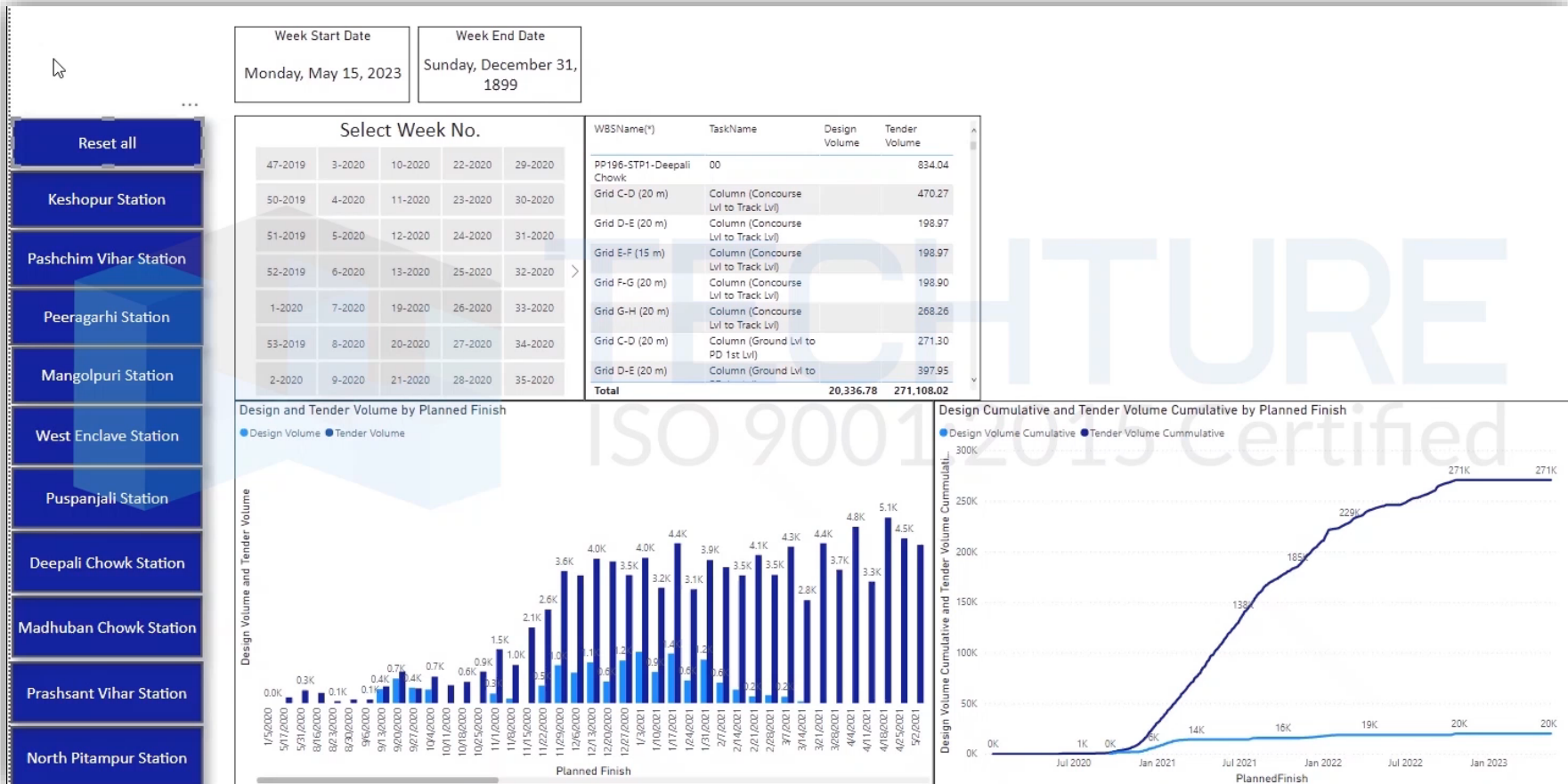
Password *

[SIGN IN](#)

☐ STAY SIGNED IN



Dashboard Generation





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

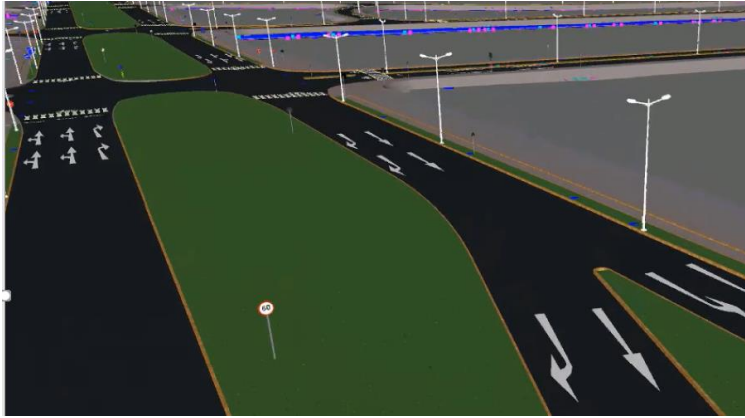
Case Study – Bidkin Industrial City & Expressways

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

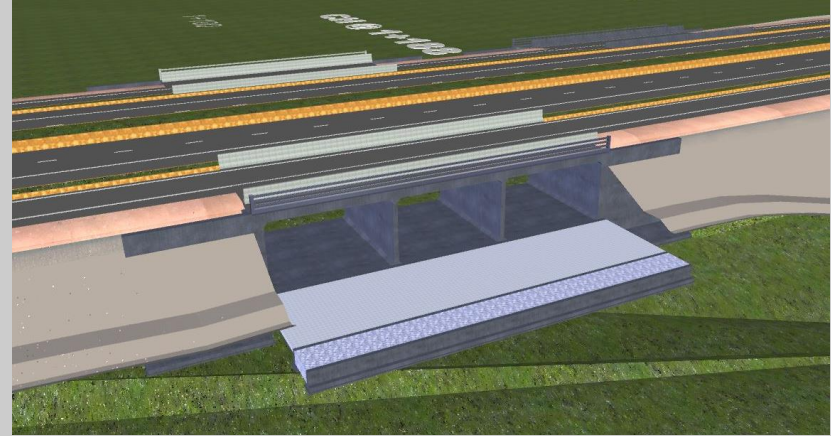
Highways & Utilities – Modelling Process

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.

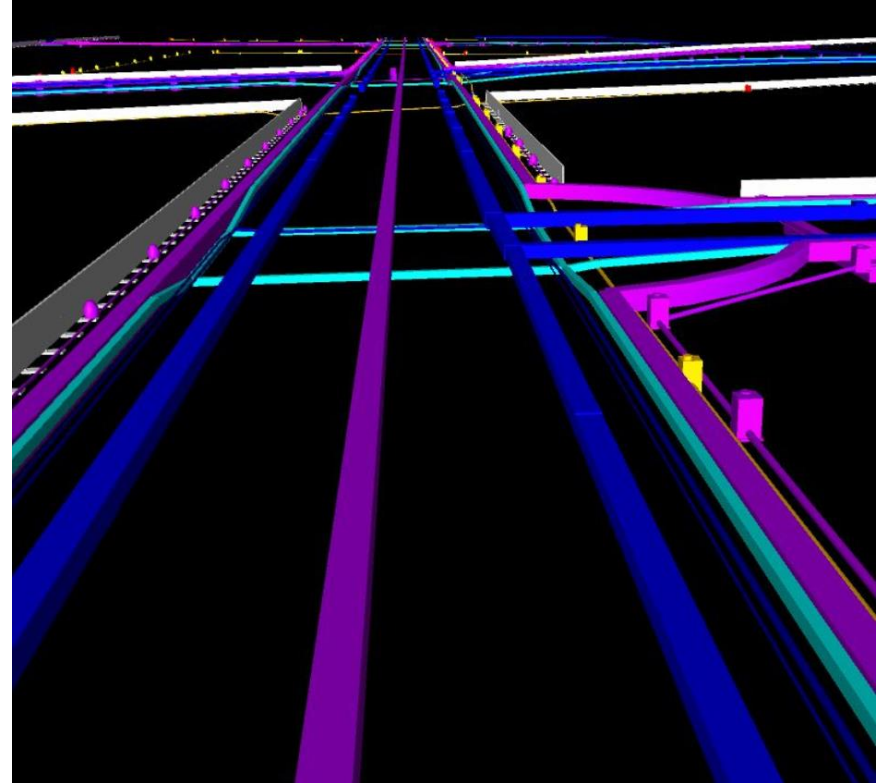
Highway Model:- Using the Plan & profile and other design drawing of highways , highway model reflecting the design highway geometry and other elements like road furniture , junctions etc can be created.

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.

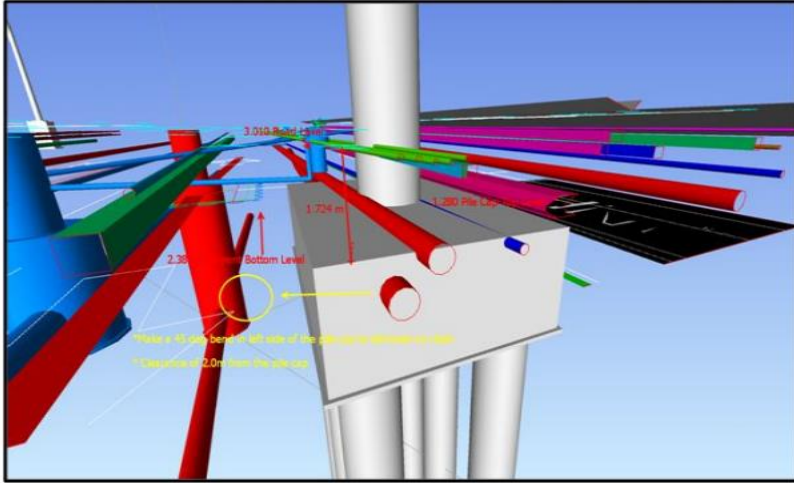


BIM for Highways & utilities

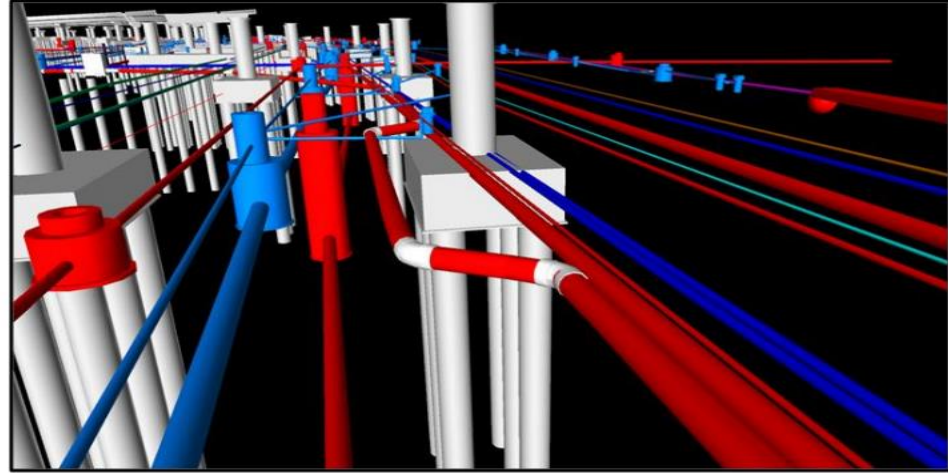
Exported Samples



Spatial Coordination & Clash Resolution

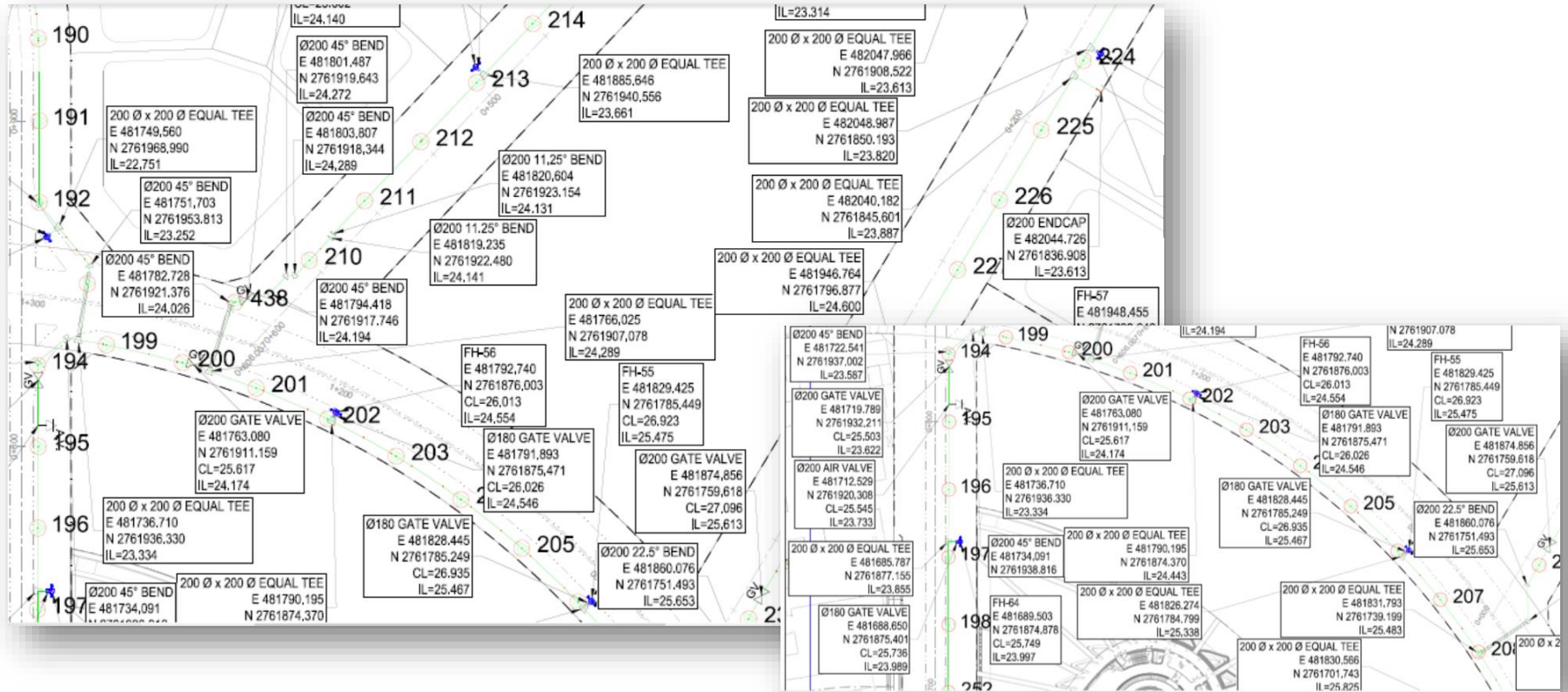


Original Model as per IFC Drawings



Revised Clash Free Model after
Technical Discussions

Use of Civil 3D for Drawings Generation



Highway & Roads BIM Modelling



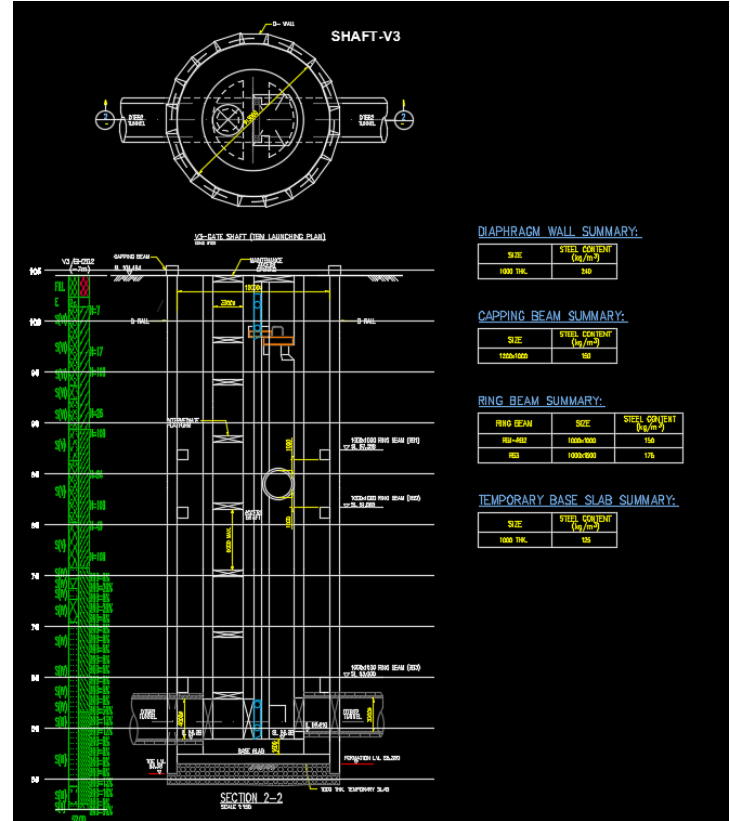
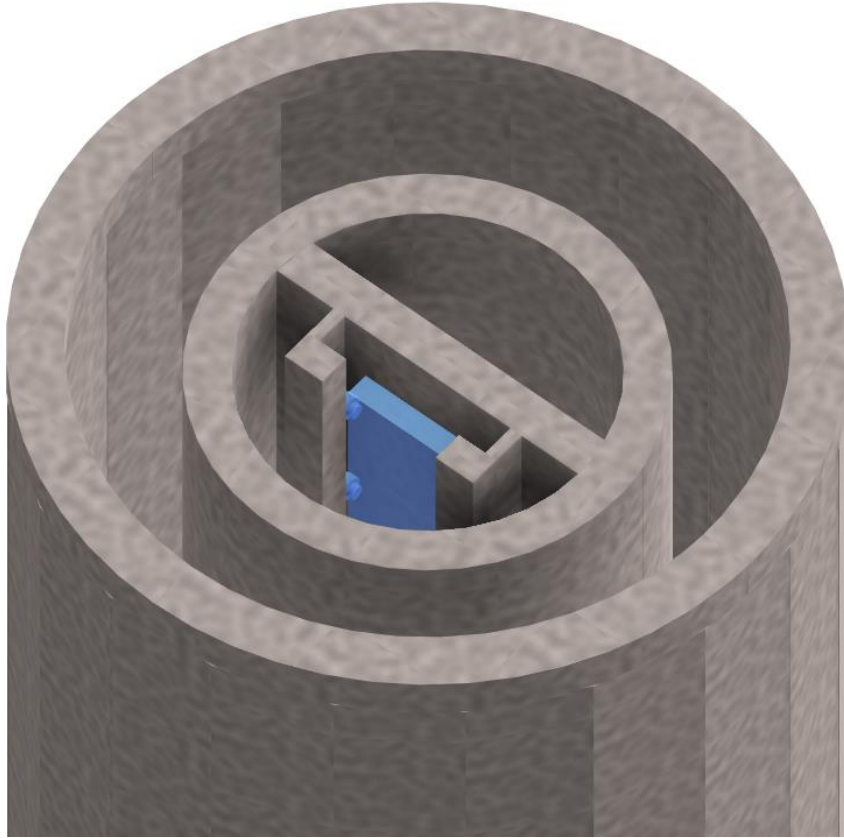
Quantity Estimation

Pipe Table							
NAME	SIZE	LENGTH	SLOPE	MATERIAL	START STRUCTURE	END STRUCTURE	PIPE INVERT LEVEL
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

- 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

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

UTILITY STRUCTURES

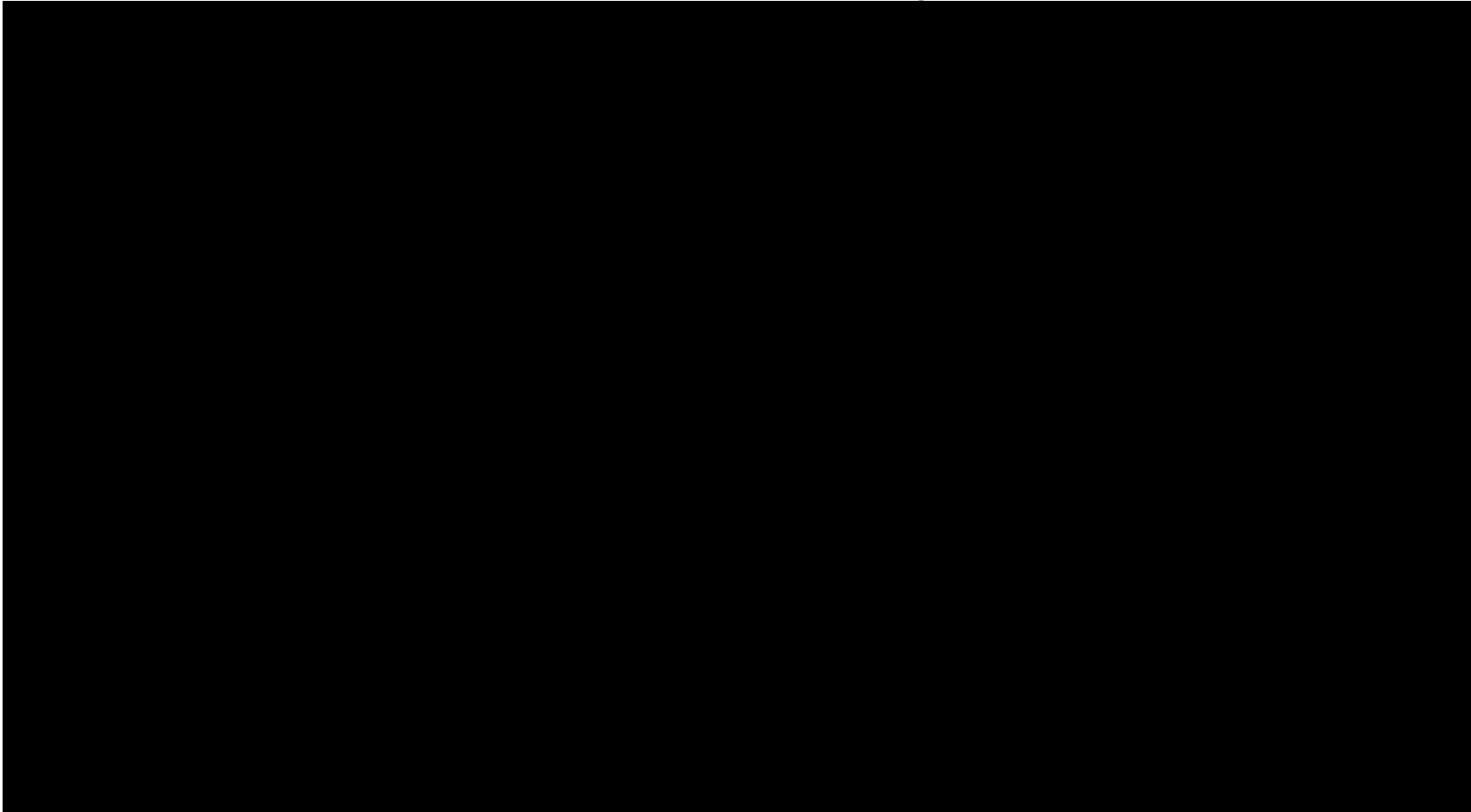


Model and Sheet Automation - Dynamo

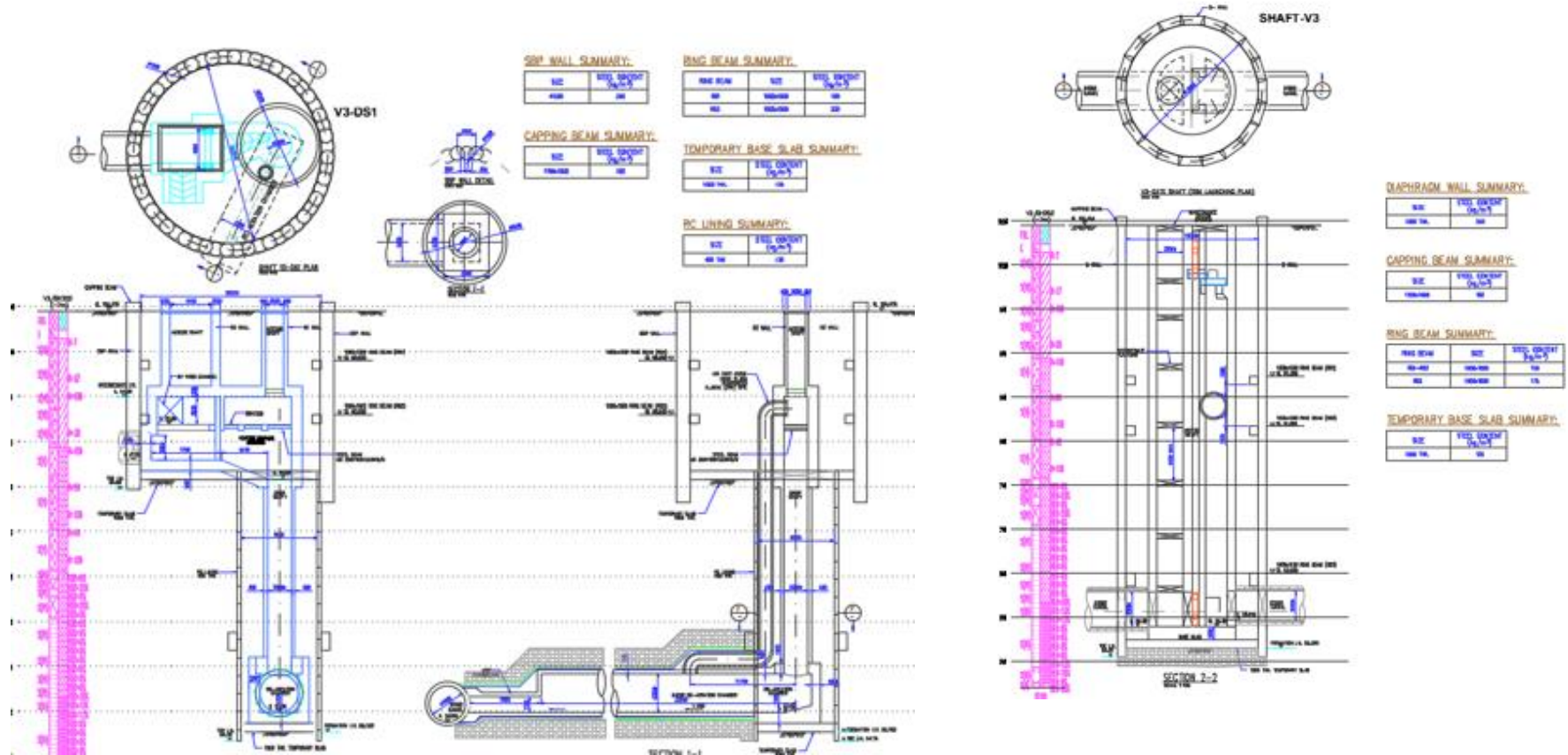
Objectives & Challenges

- 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.

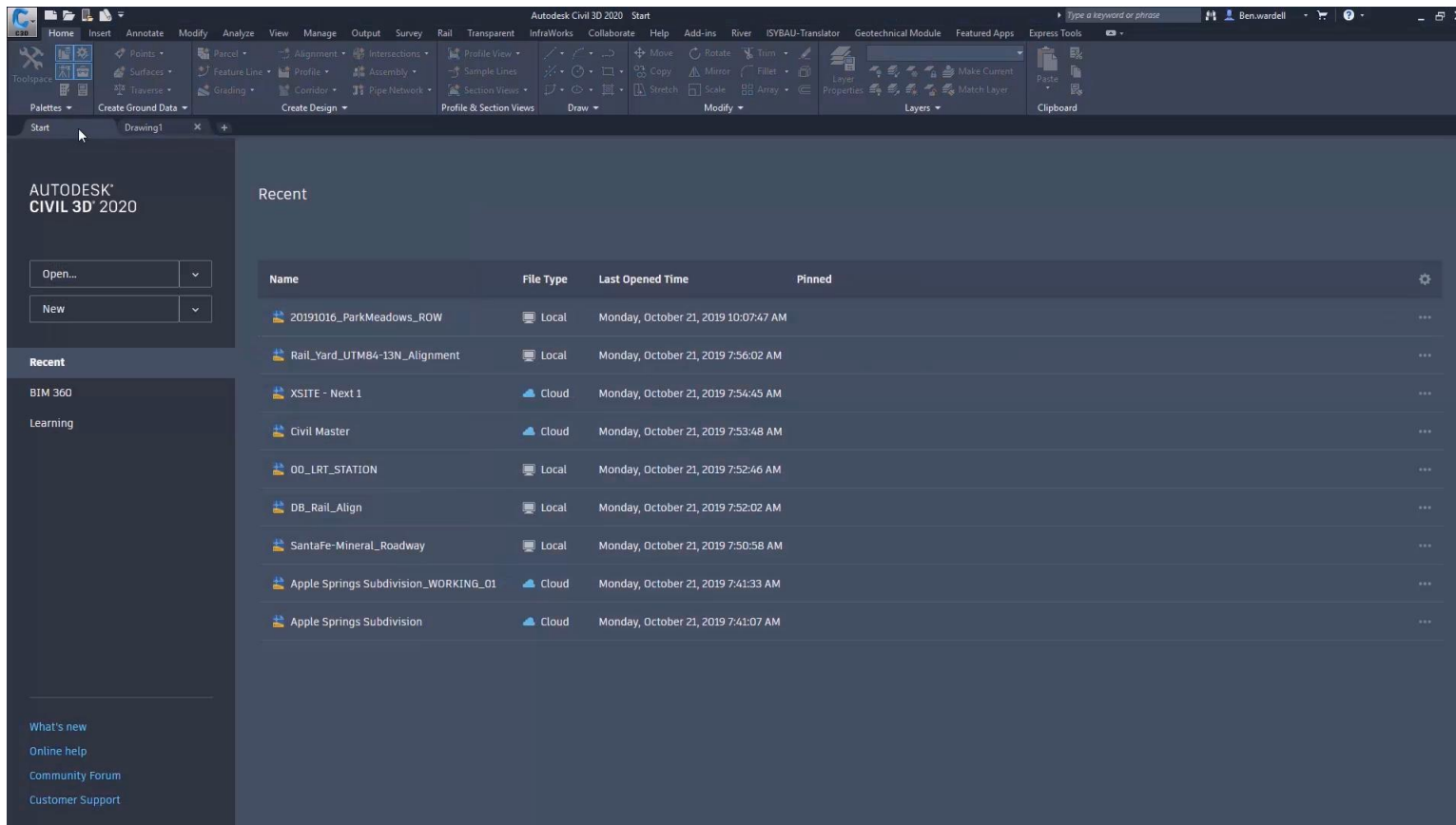
Model and Sheet Automation - Dynamo



Creation of Shop Drawings



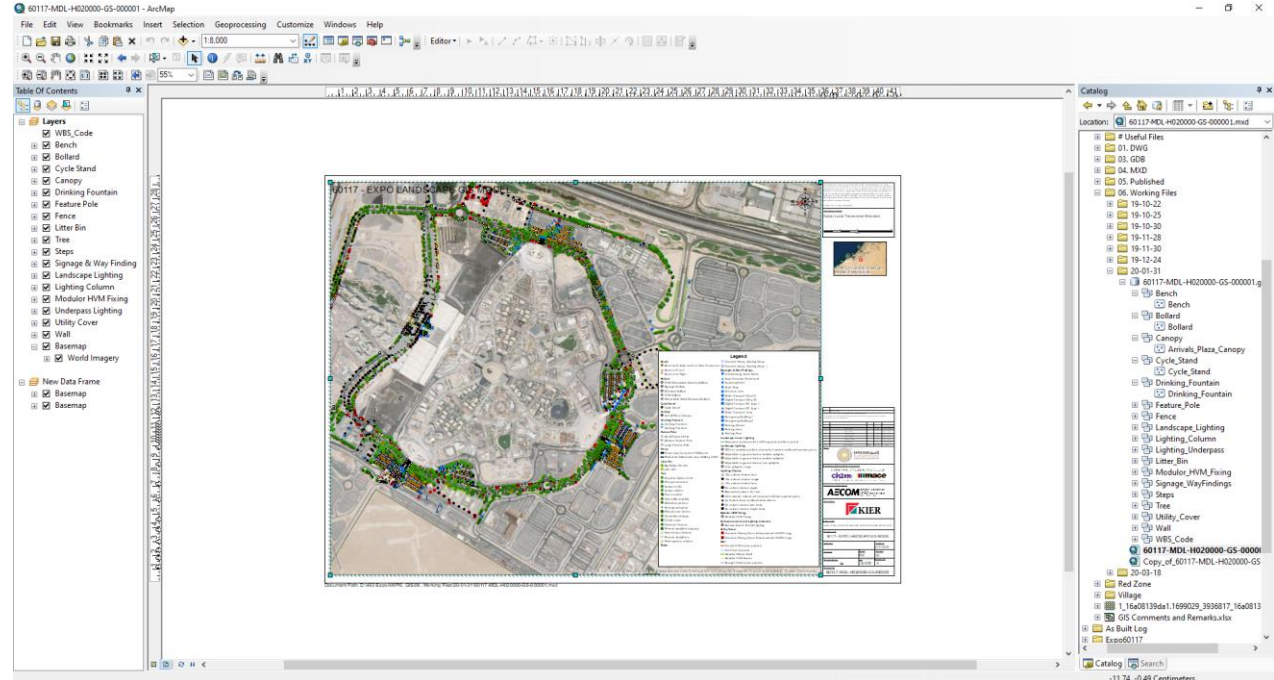
Collaboration using BIM Collaborate Pro - ACC



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.

The background is black with four abstract, metallic-looking geometric shapes in the corners. These shapes are composed of flat, reflective surfaces that catch the light, creating bright highlights and dark shadows. They appear to be fragments of larger, complex structures, possibly representing architectural or industrial design elements. The shapes are positioned in the top-left, top-right, bottom-left, and bottom-right corners, framing the central text.

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