AU LONDON 2019

Partha Sarkar & Mohammed Riaz

ARCADIS Design & Consultancy for natural and built assets

AUTODESK. UNIVERSITY

Doing ‘More’ and ‘Better’ with ‘Less’ using Automation

Partha Sarkar & Mohammed Riaz

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About the speaker

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Agenda

- Health & Safety
- How design and engineering automation helps us achieve More & Better with Less.
- Tools and Technologies to implement automation in Infrastructure Projects.
- Automation of structural design & modelling using Dynamo & Revit.
- Q & A

Health & Safety

“Stand4Strength Challenge”

“We may retire from work, but **we should never retire from life** !”

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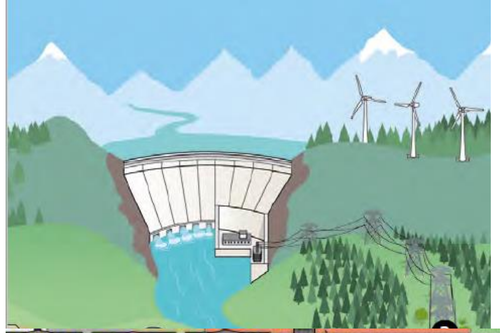
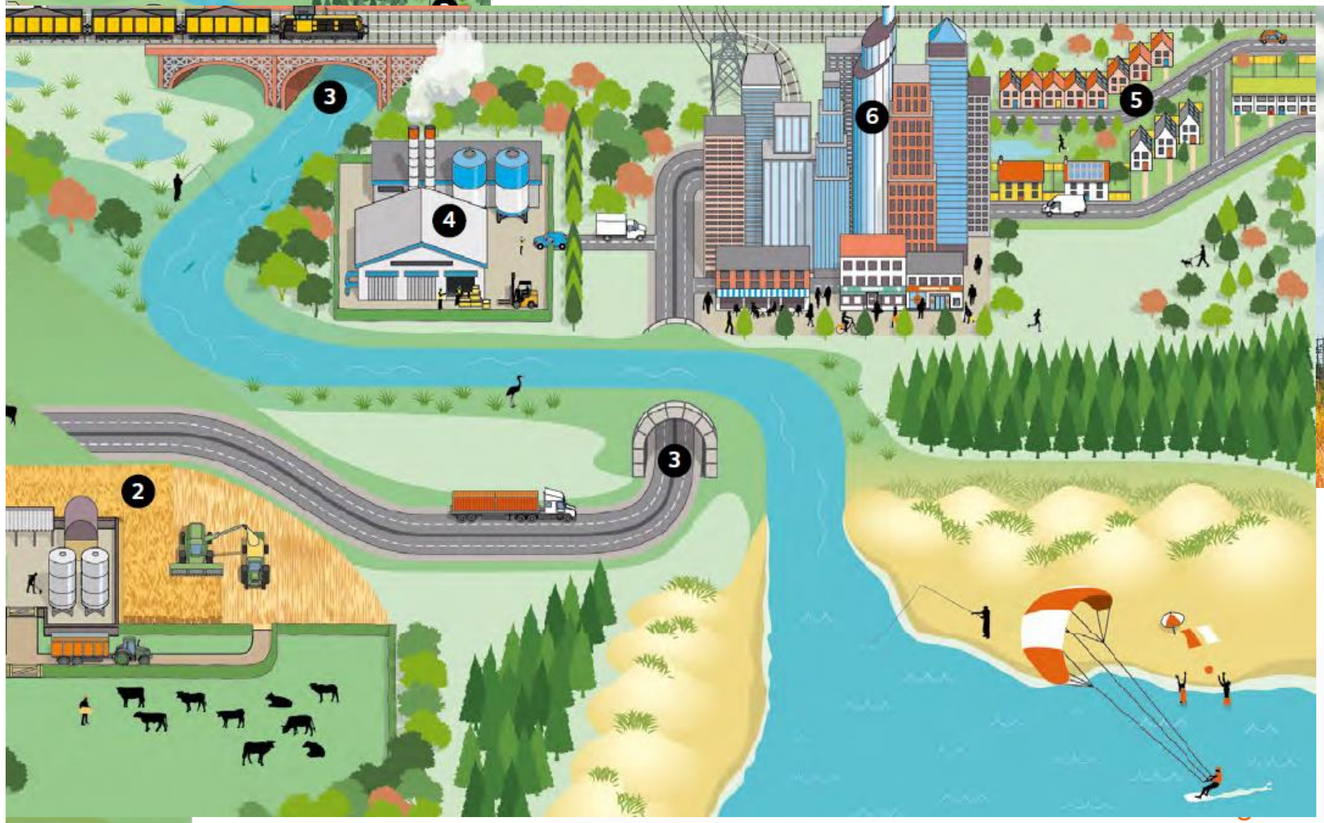
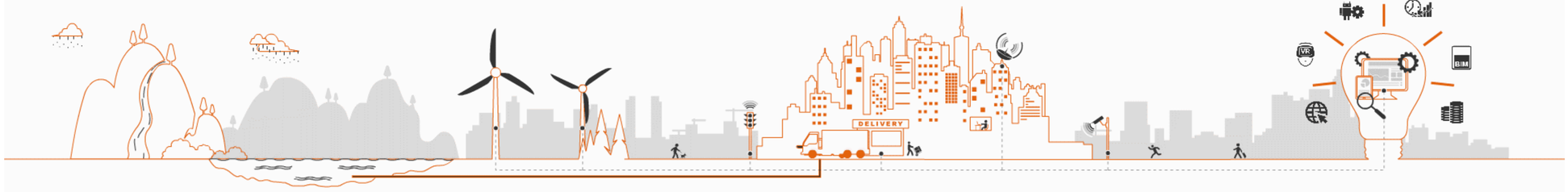
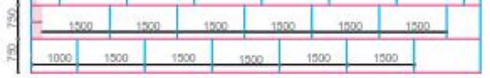




Arcadis Improving quality of life

Reimagine the client experience





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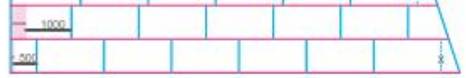

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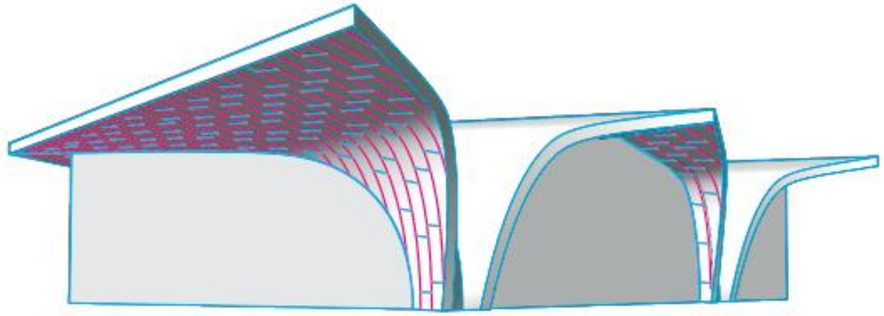
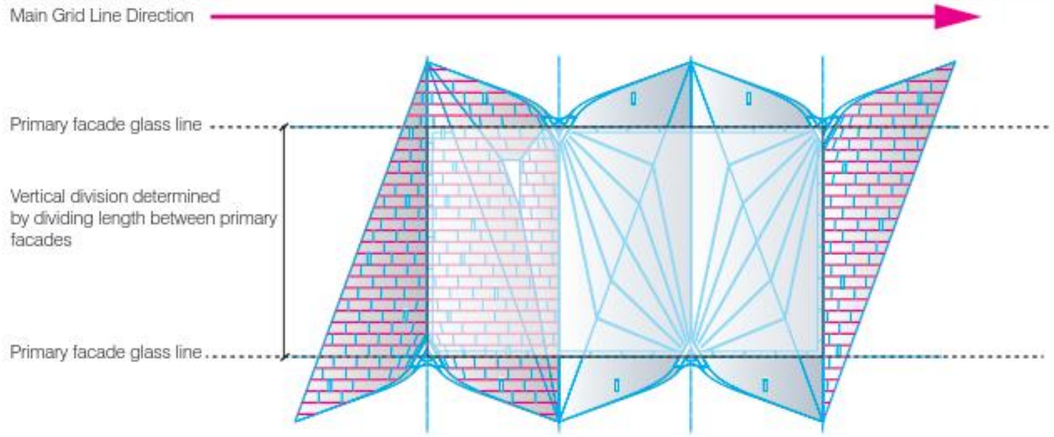
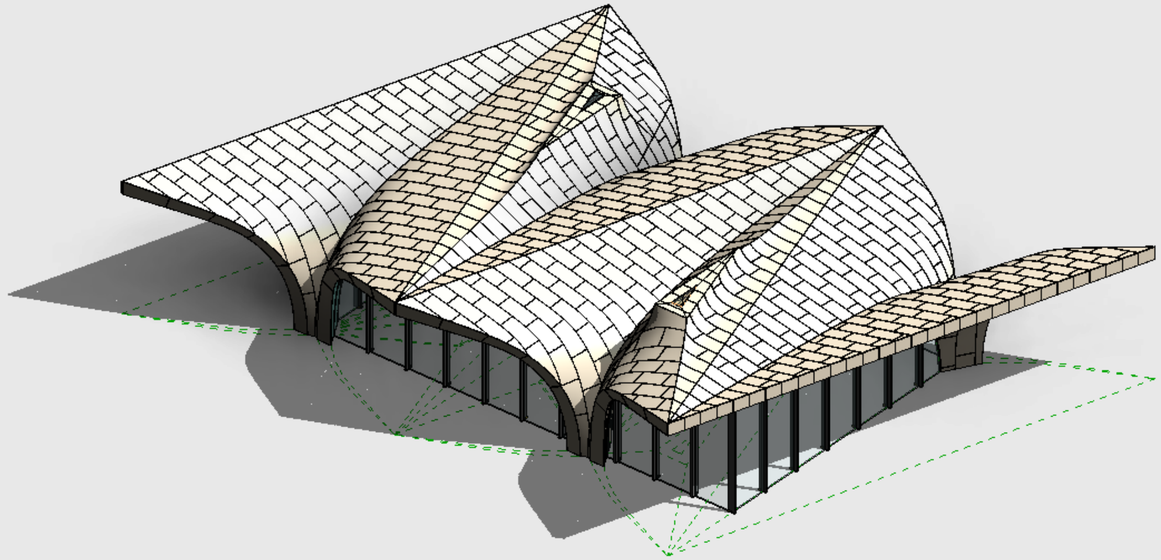
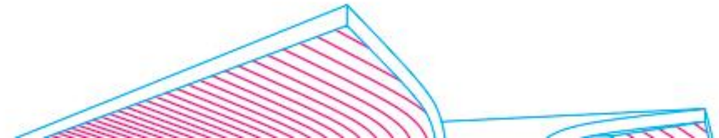


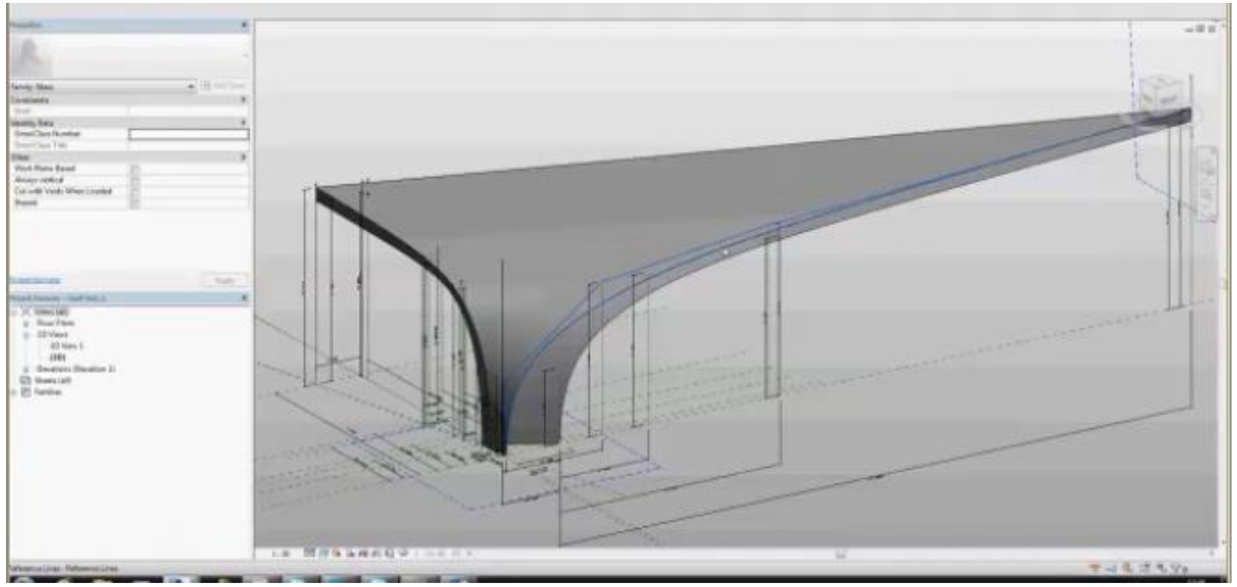


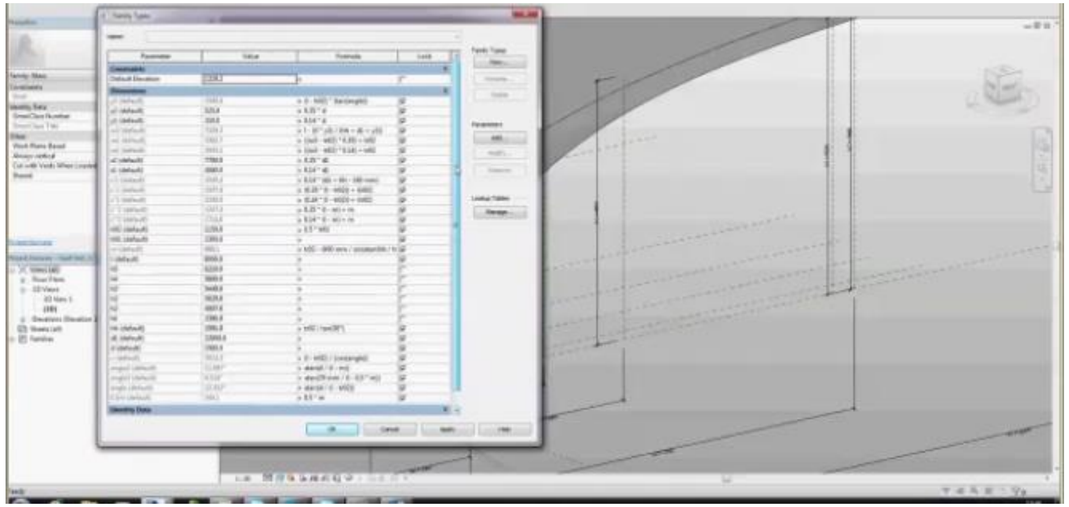


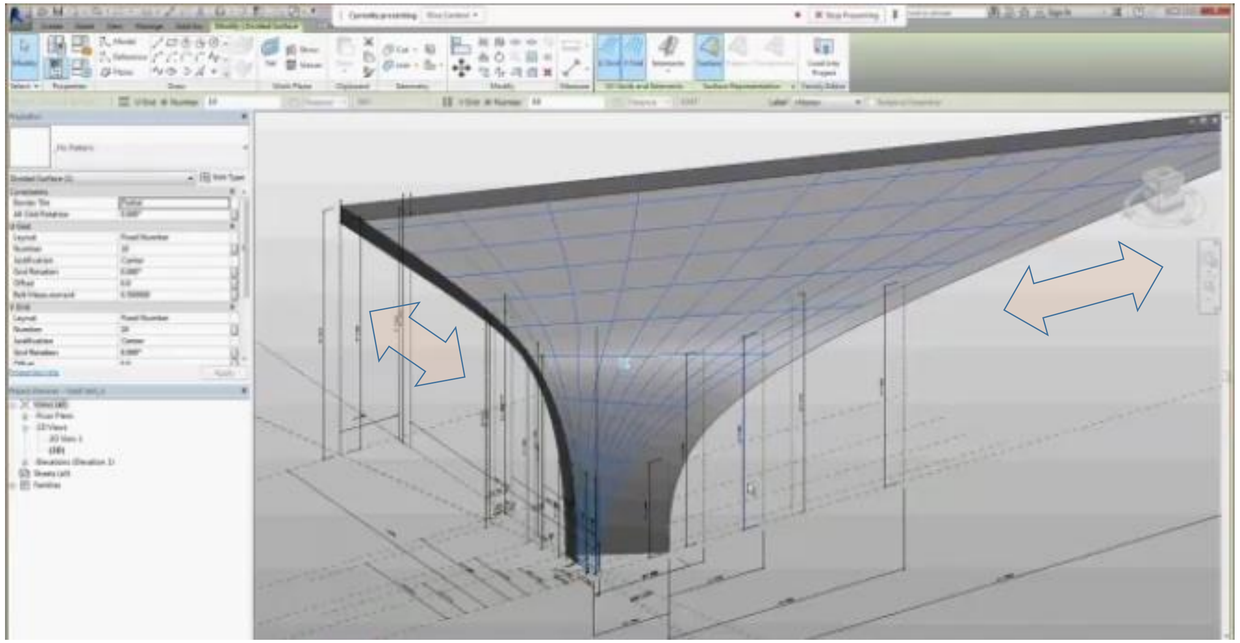


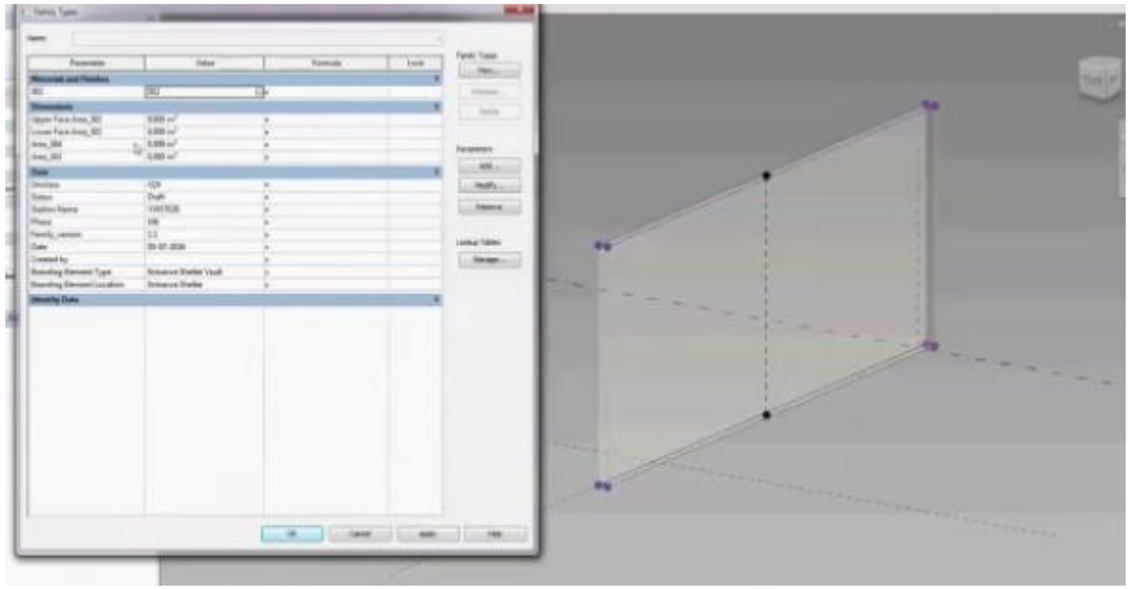
Limited Revit modelling functions:

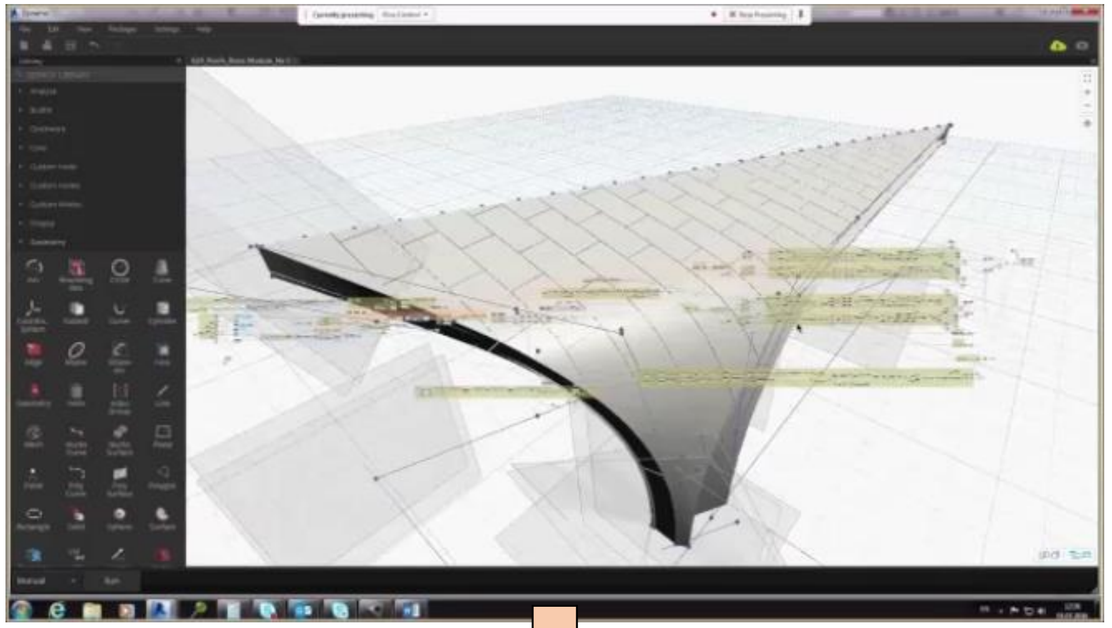
- Non parametric functions for complex shapes (Bezier Curves)
- Large number of parameters necessary for simple operations
- Minimal Surface generation and modelling
- Inflexible surface division
- End result only 40 % usable

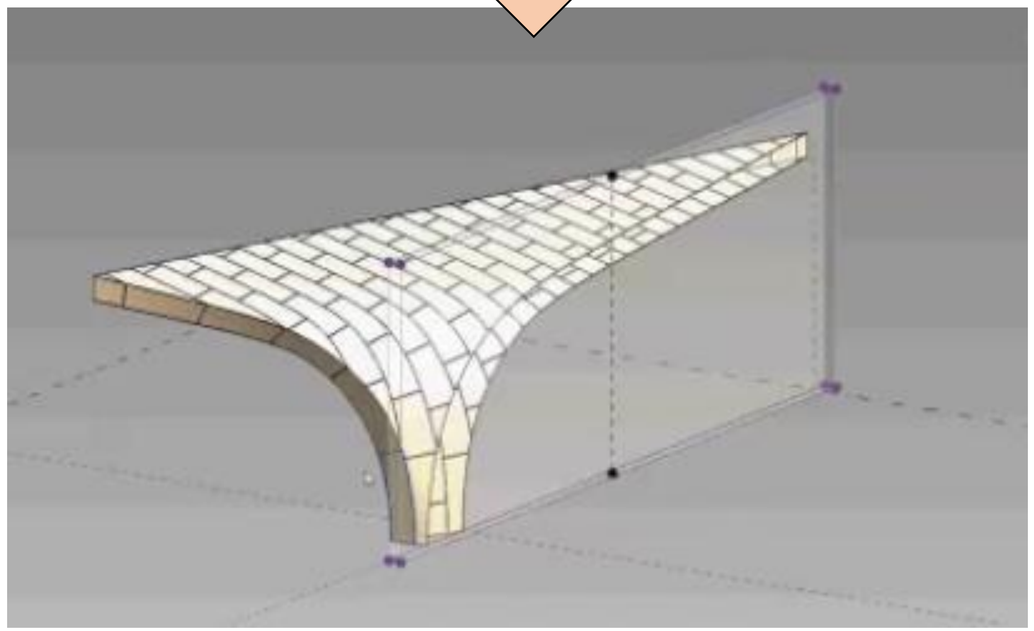






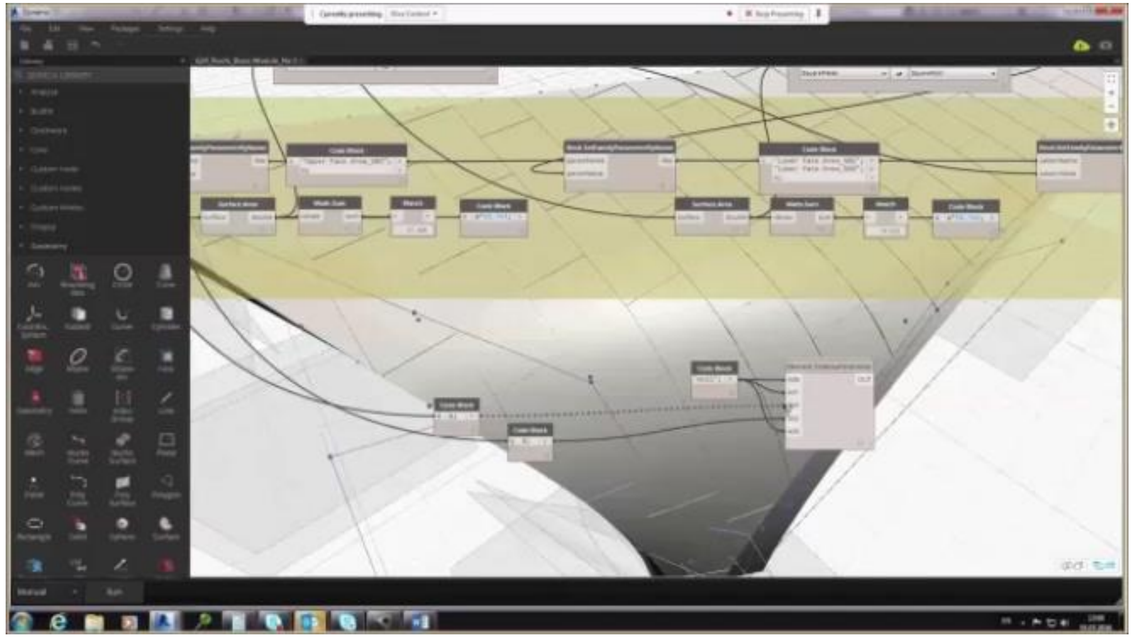


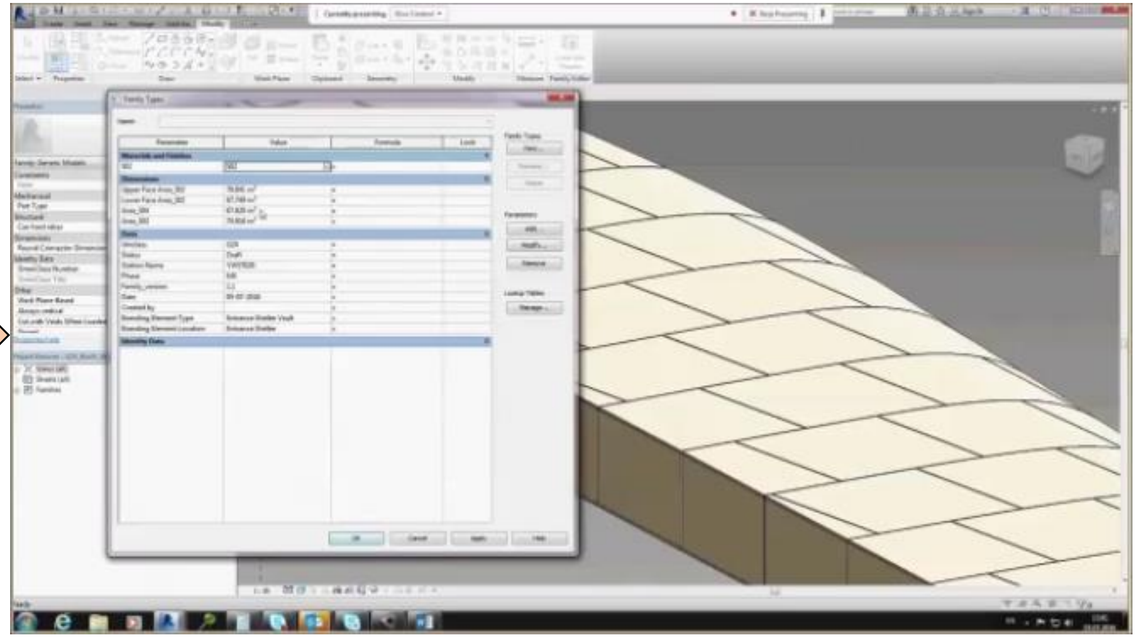




Revit / Dynamo modelling functions:

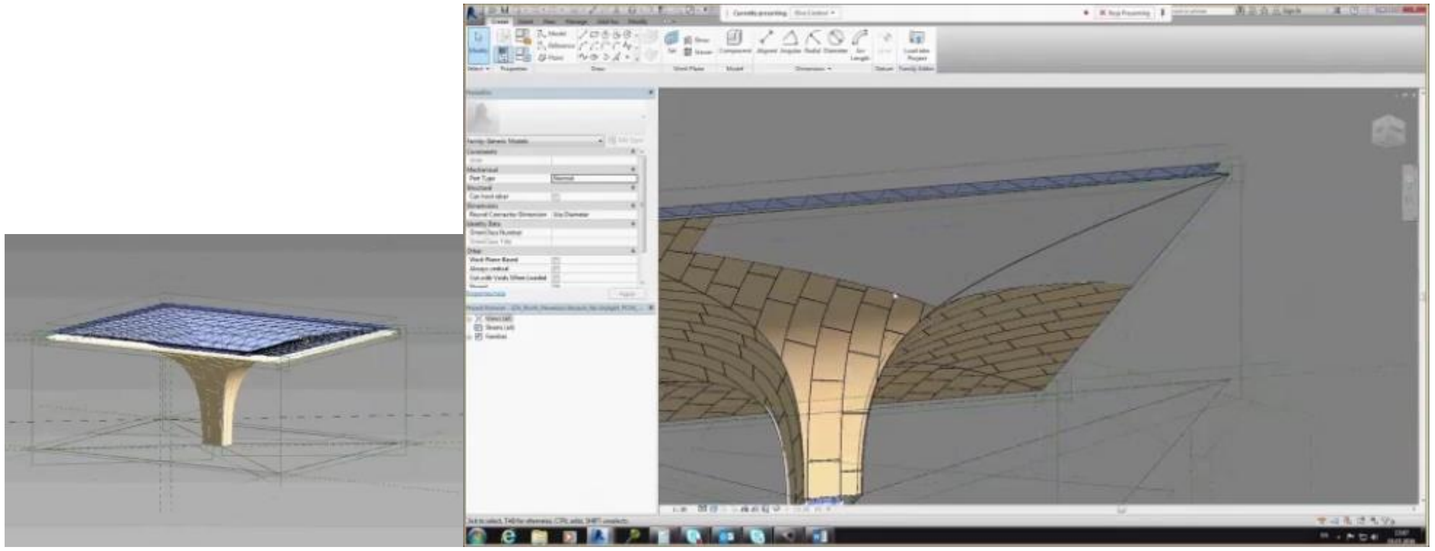
- A Revit family template was created with predefined parameters
- Dynamo scripts were used to generate geometries within the Revit families
- Full Surface generation and modelling was done using Dynamo
- Parameters were introduced to deal with geometry changes
- Multiple parameters were available and editable in Revit Family

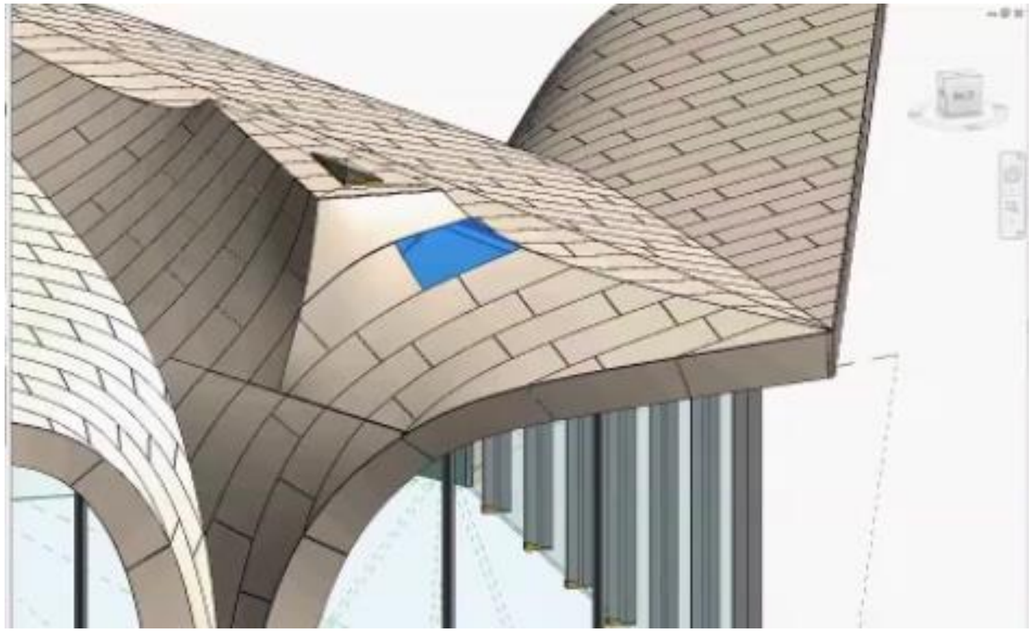


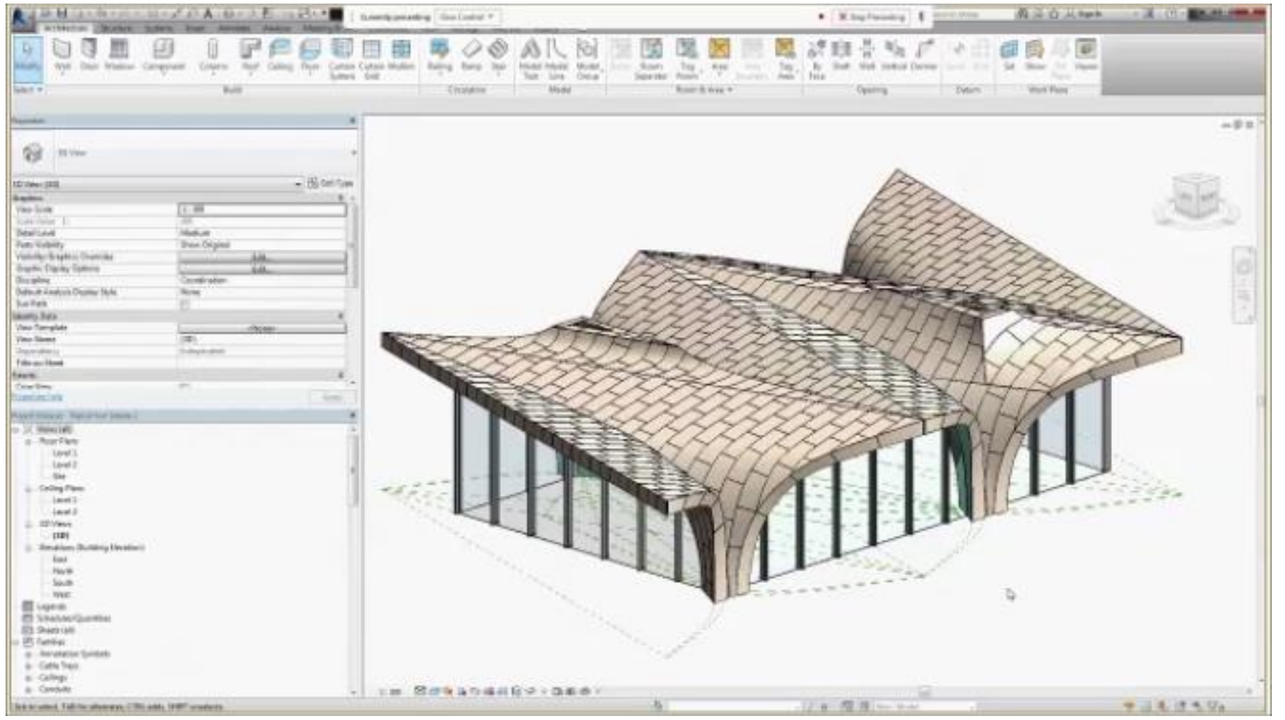


Revit / Dynamo modelling functions:

- It became easy to add or remove parameters
- Multiple components created with Dynamo was easy to be assigned to a single family
- Components could include Structural and MEP references
- **100% usable elements!**

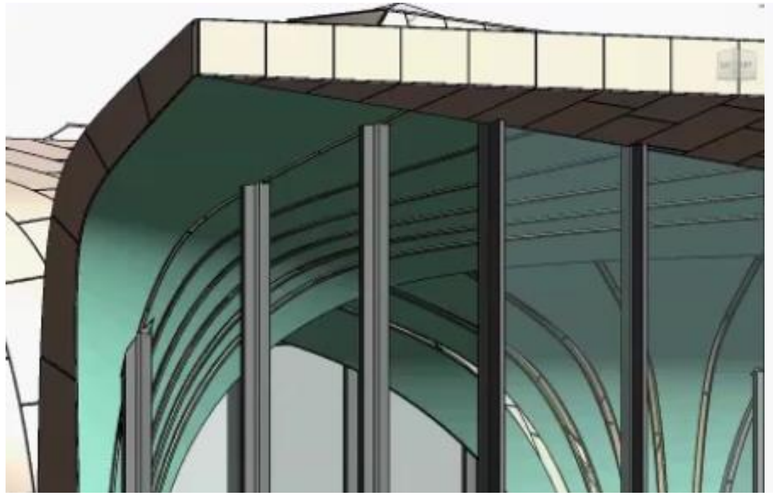


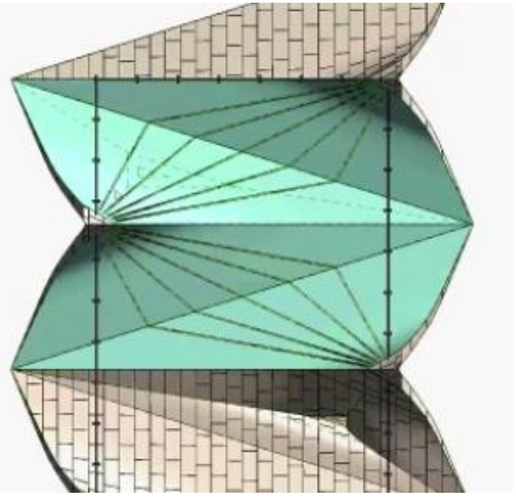


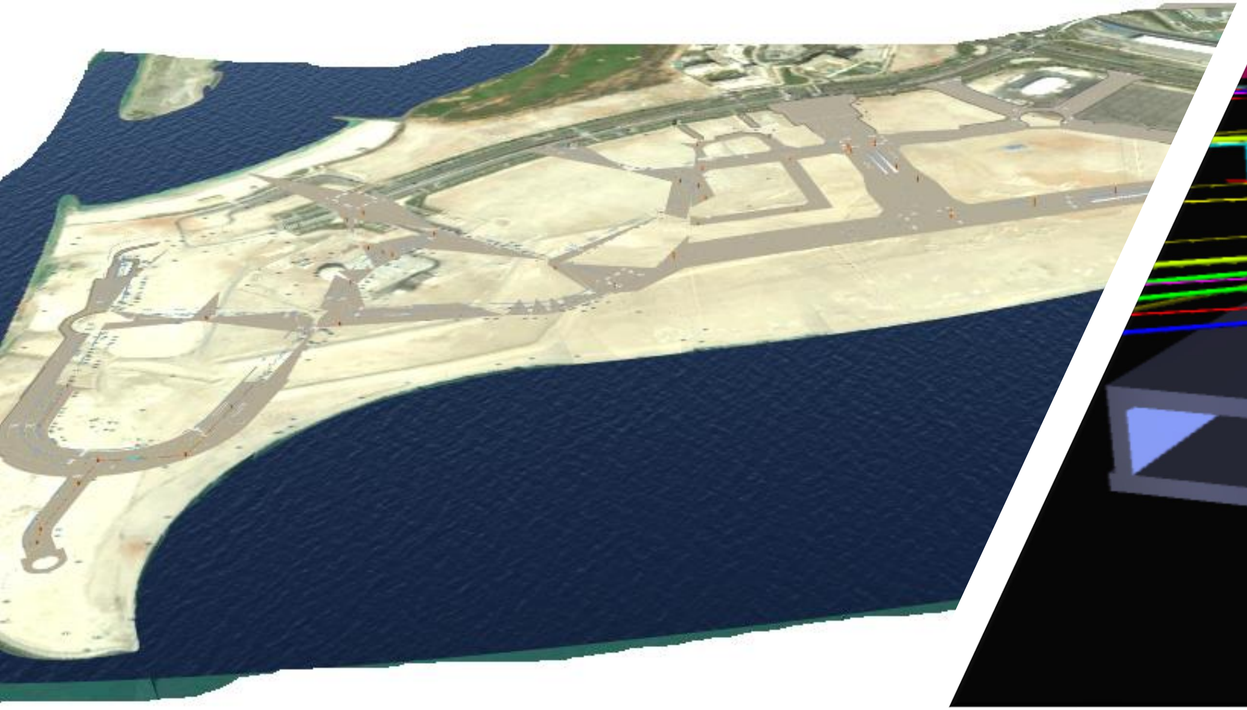


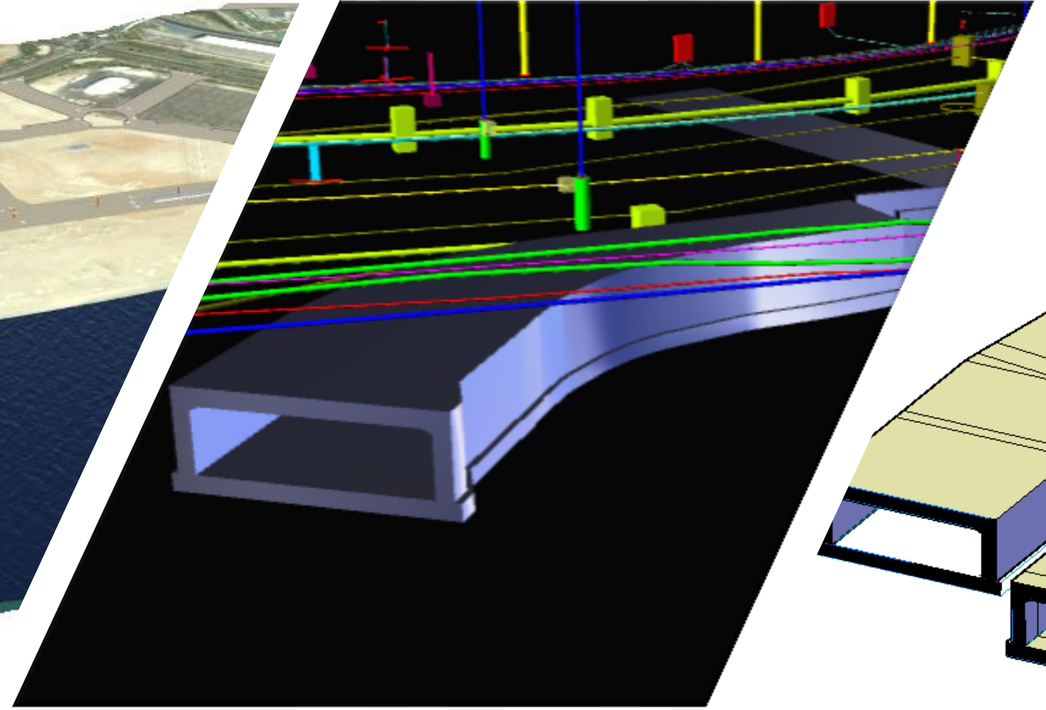
Project elements:

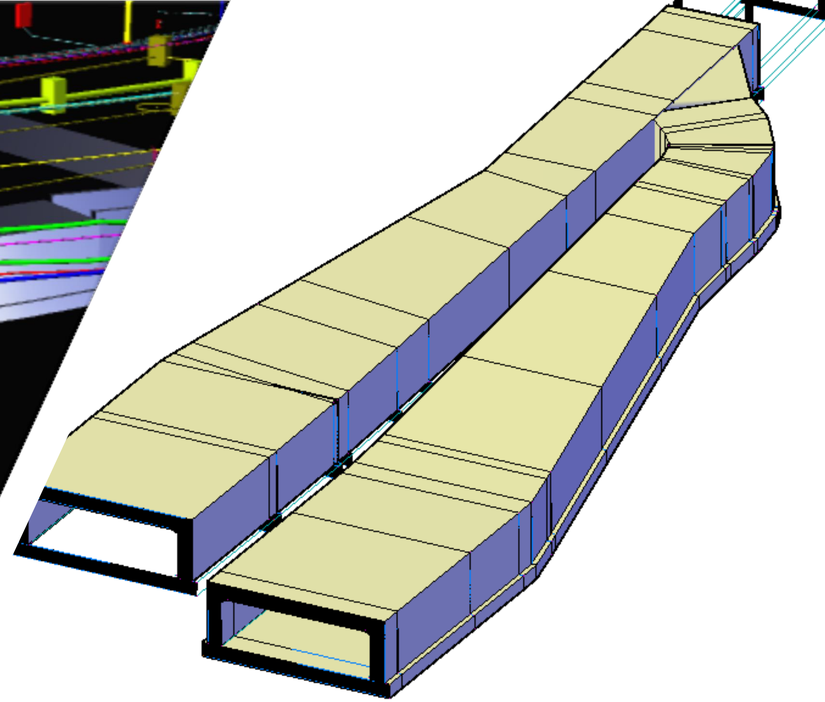
- Full model generated using dynamo definition with Revit natives
- Easy to follow project components due to schedulable parameters
- Coordination with other disciplines were easy to implement

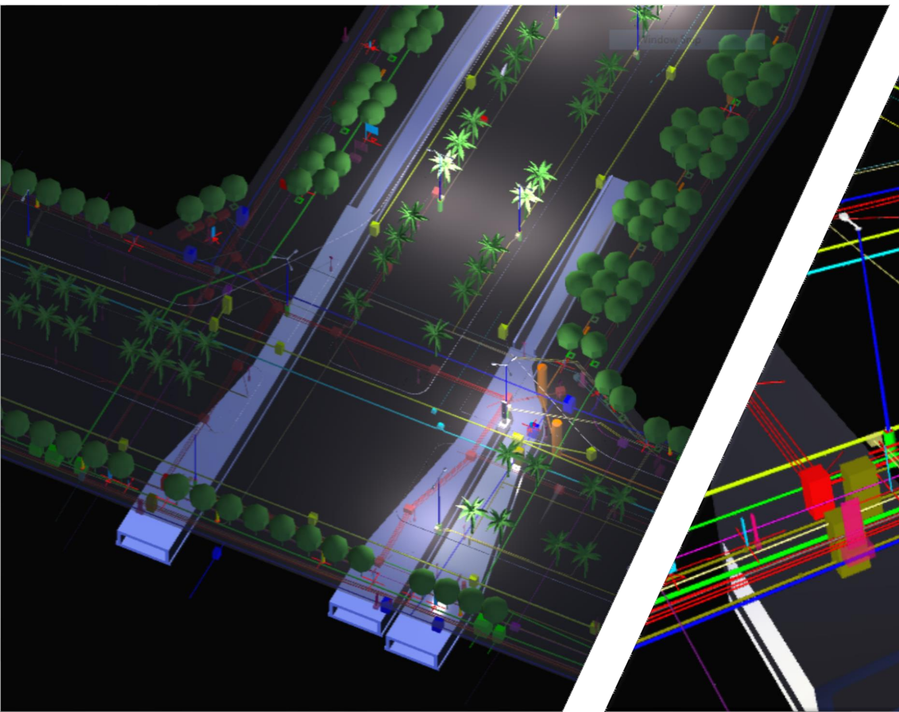


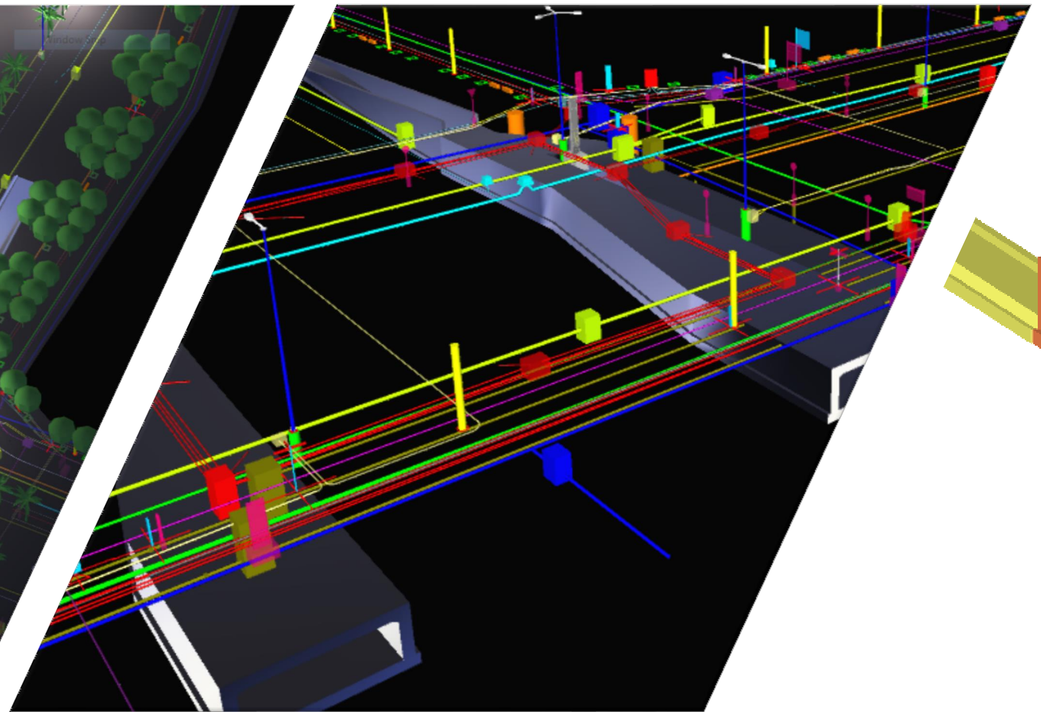


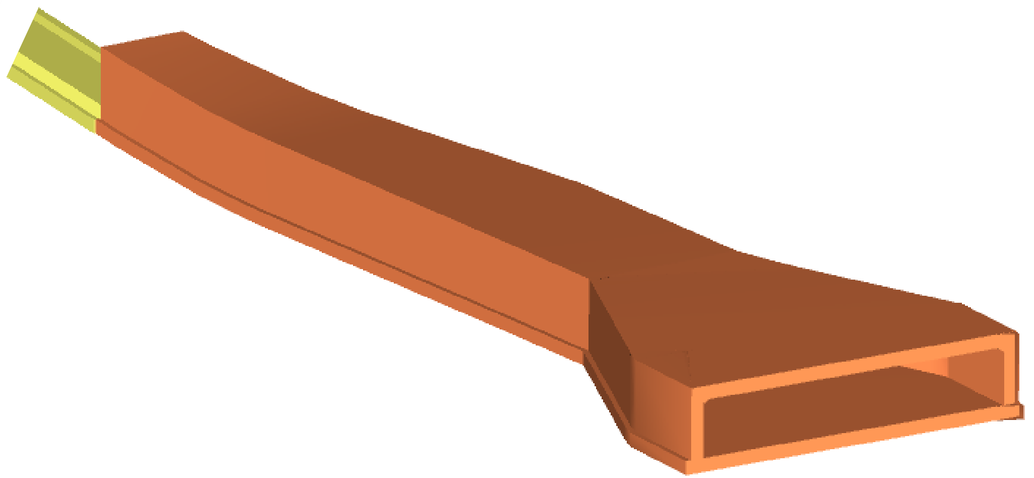


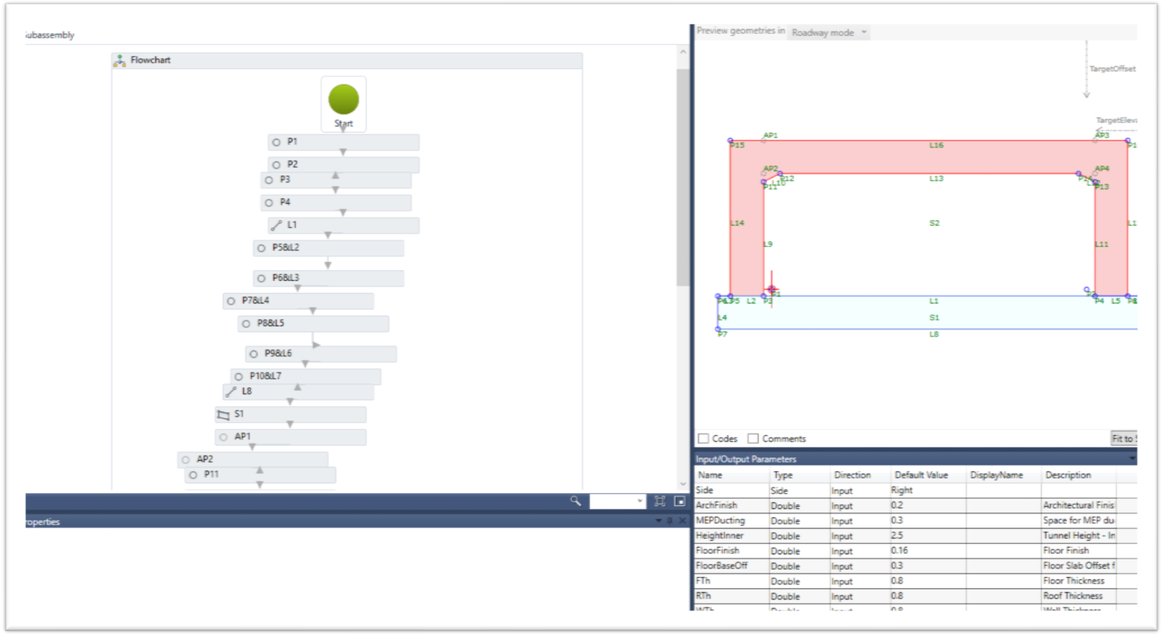








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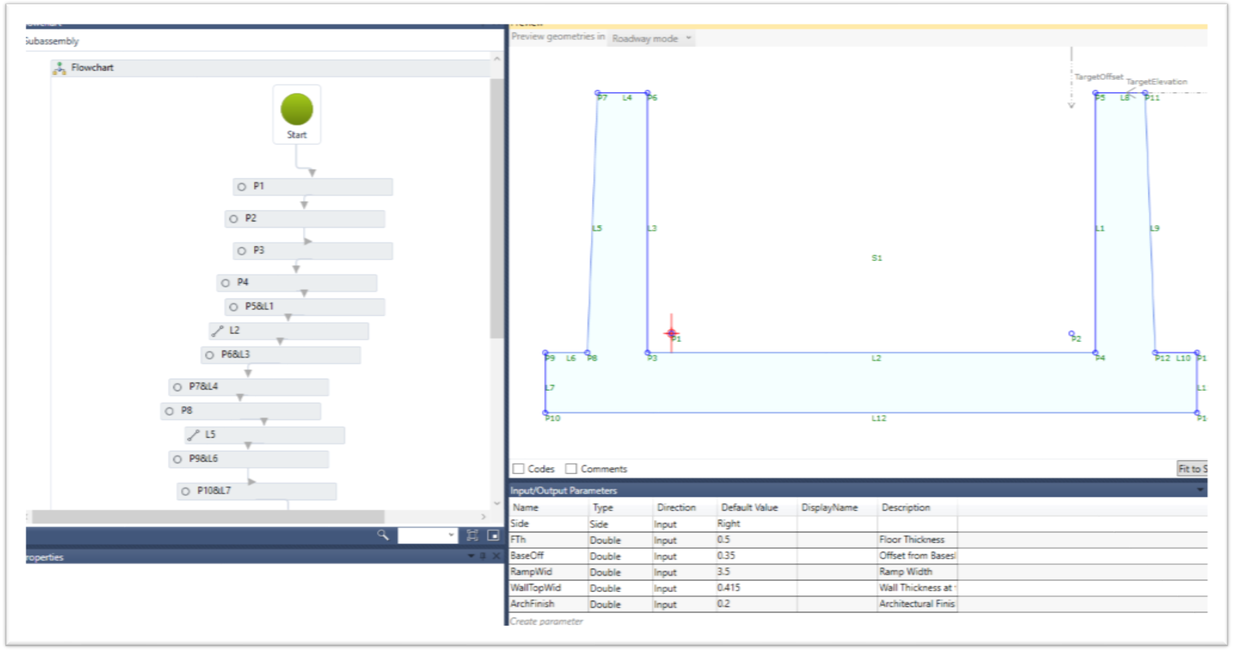
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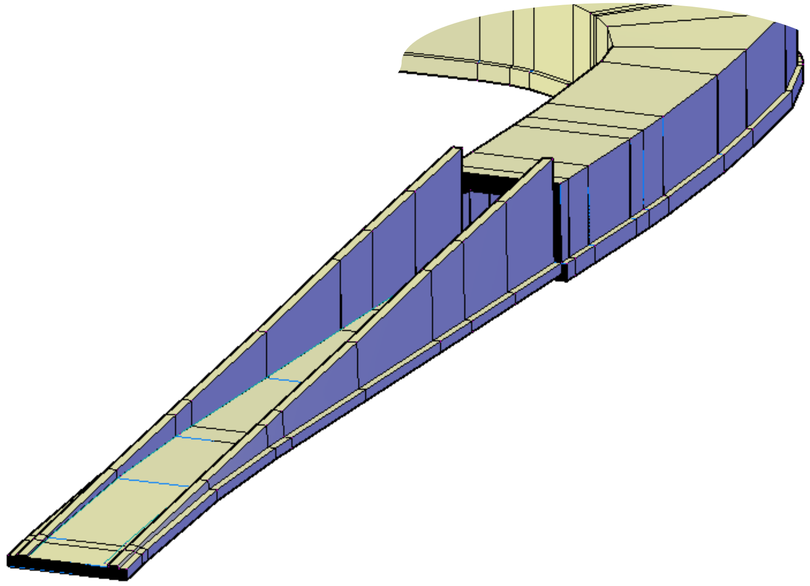

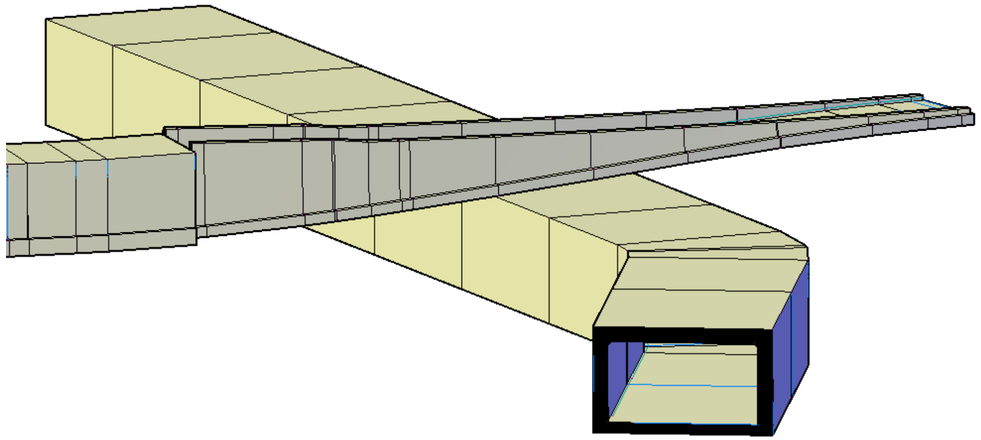

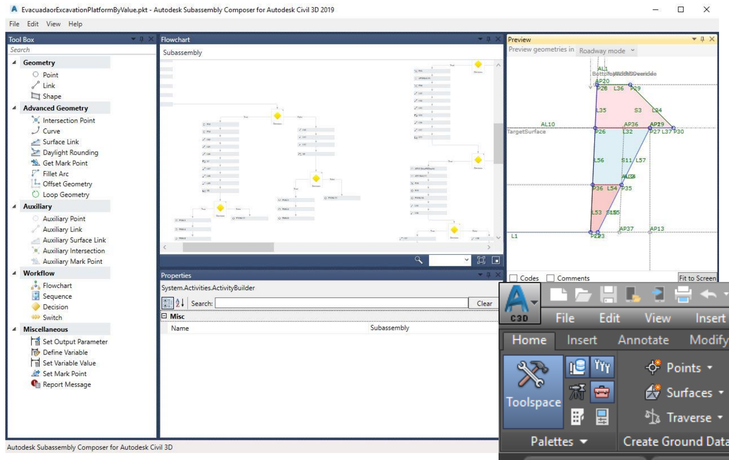
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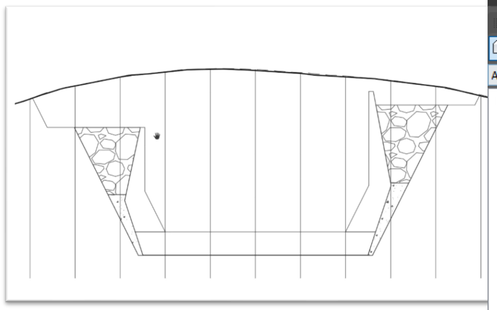

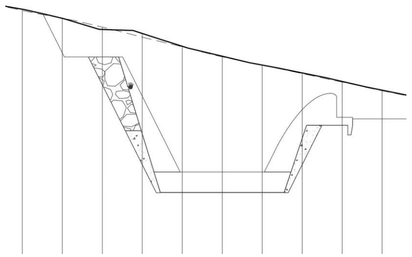

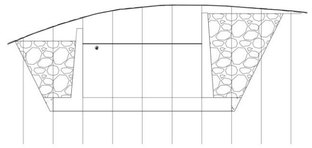

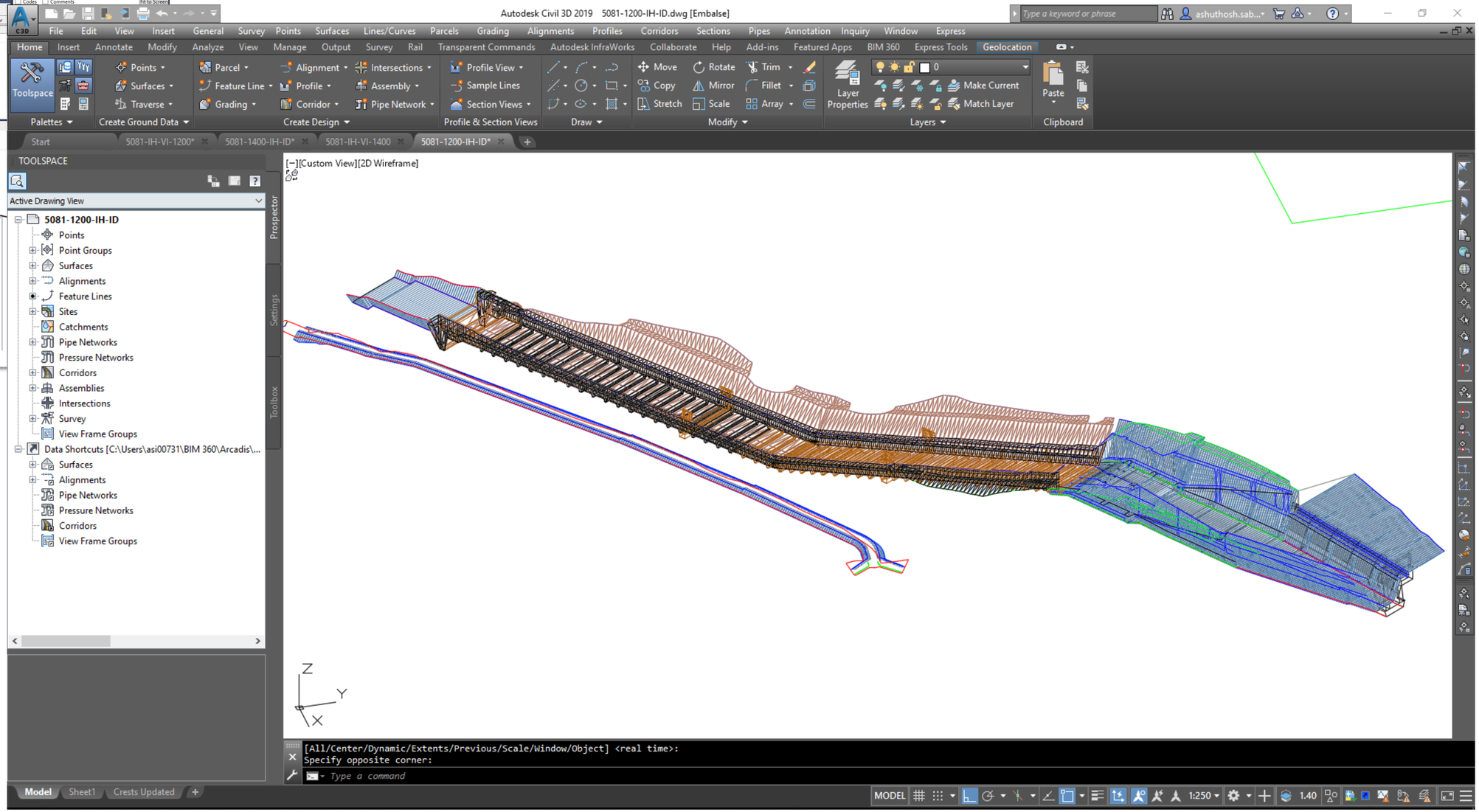
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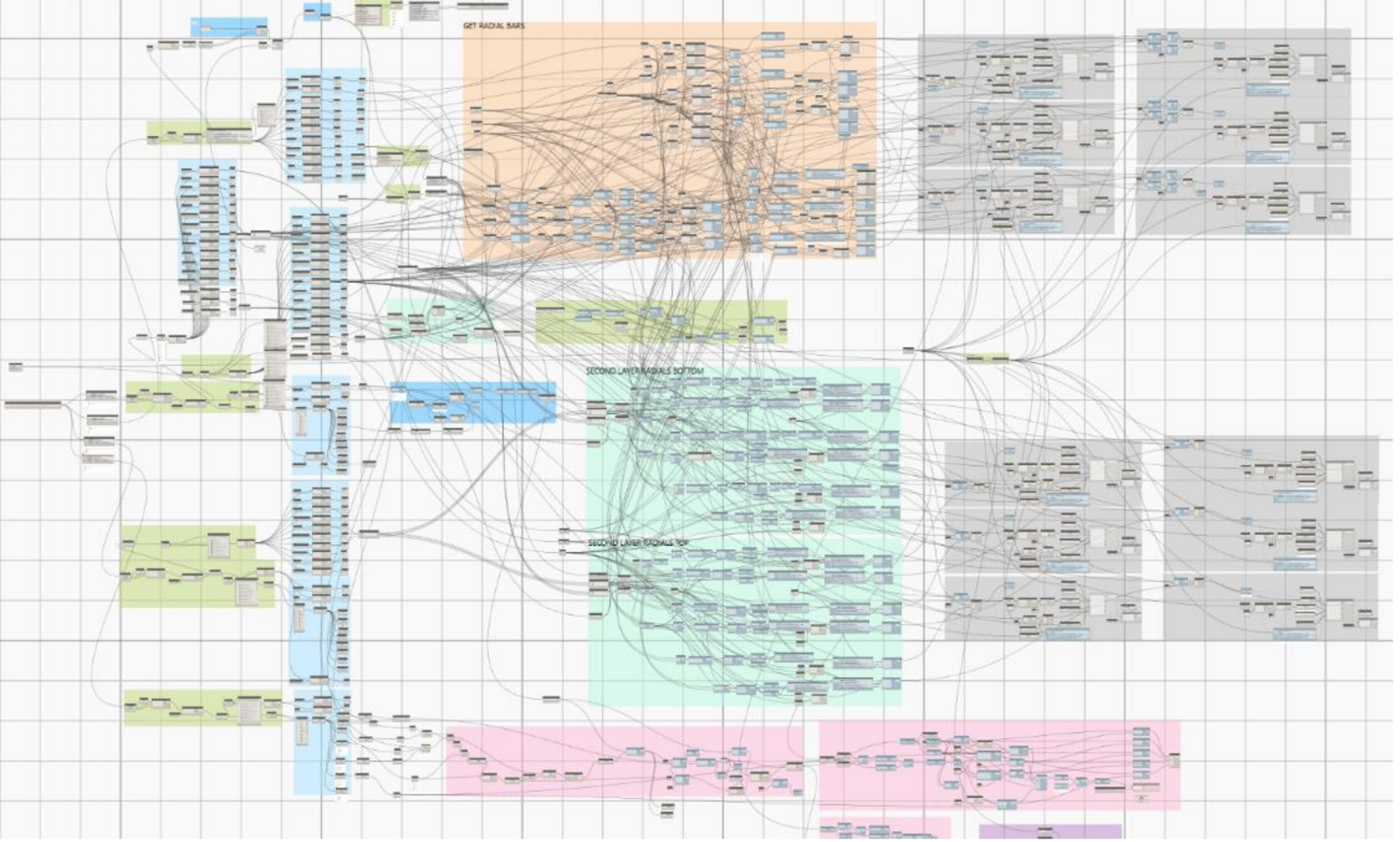
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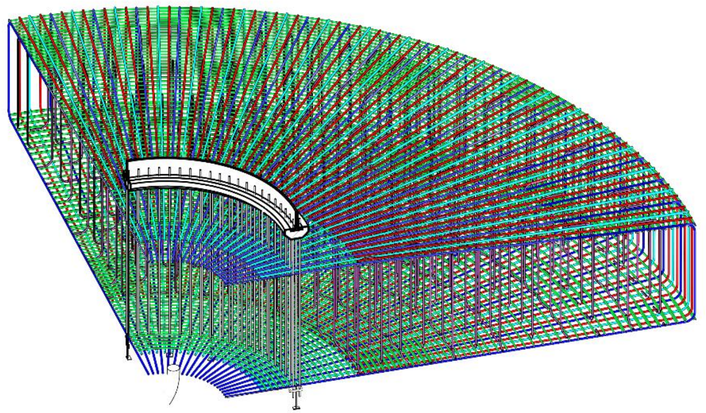

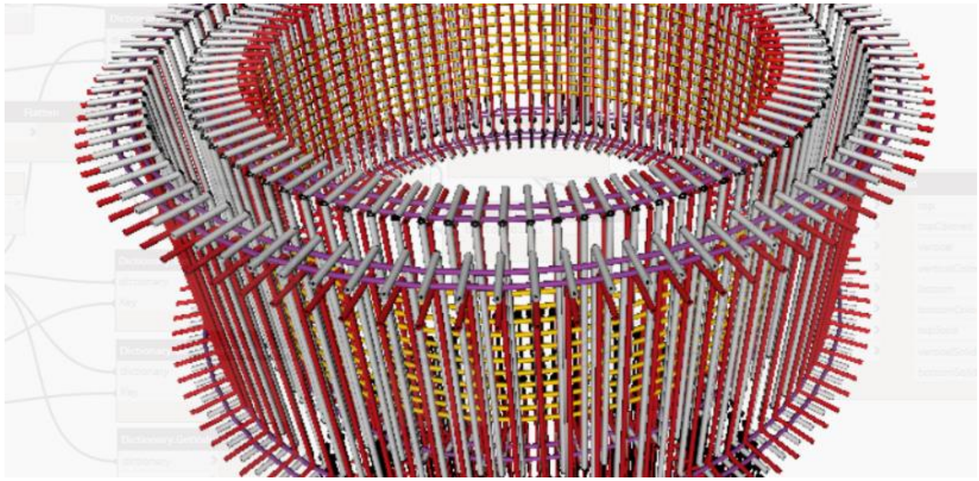

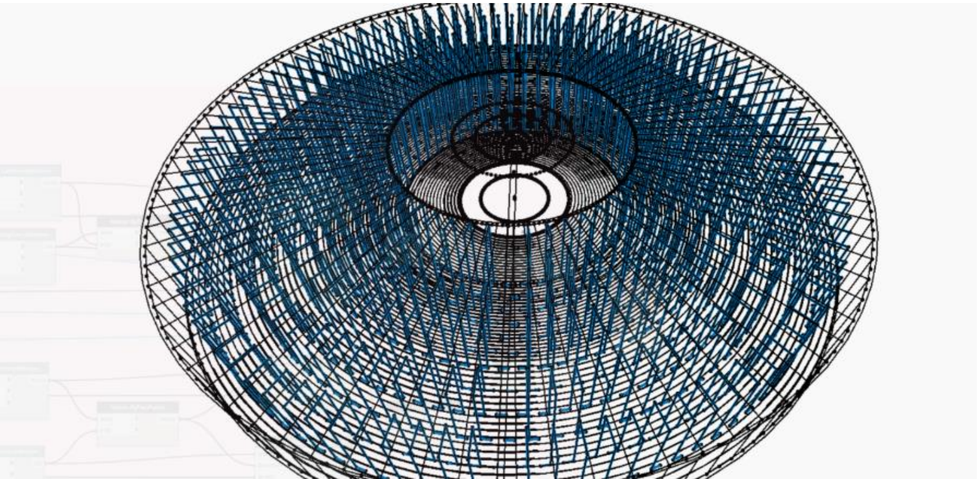

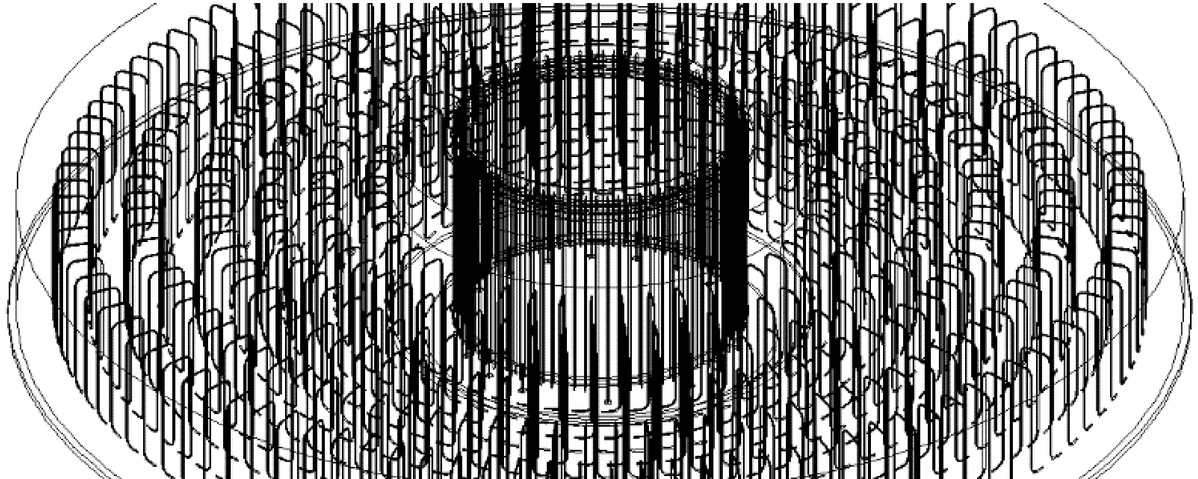

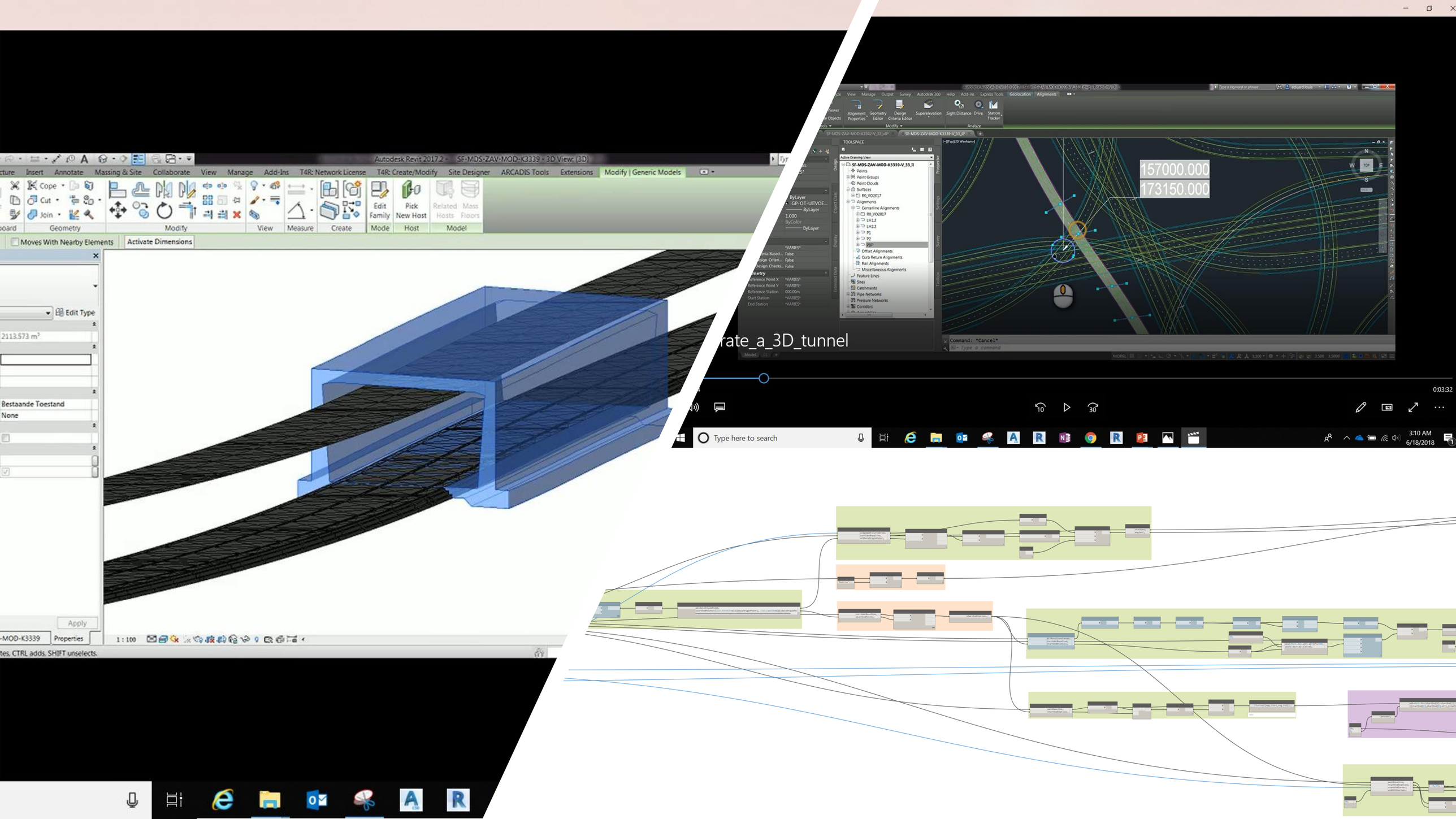
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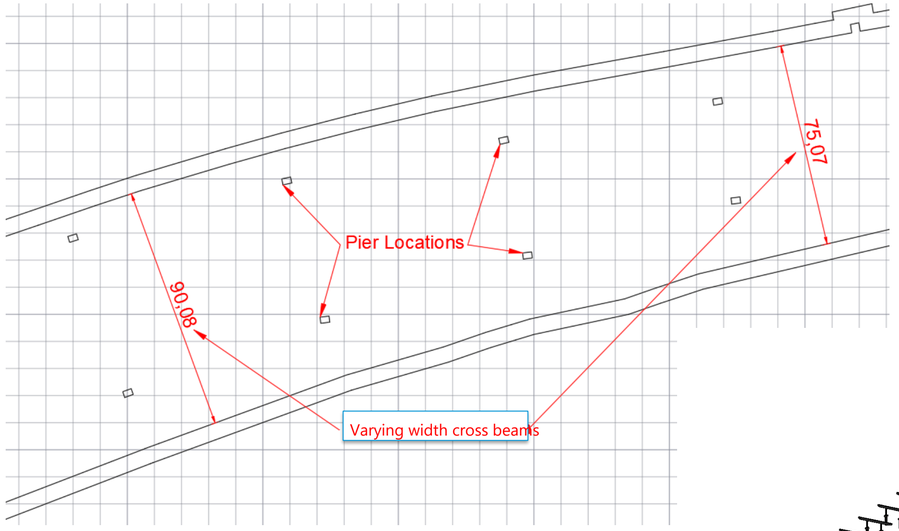
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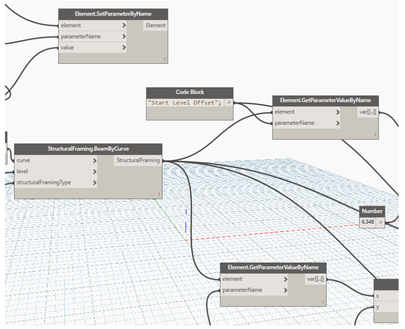
Varying width cross beams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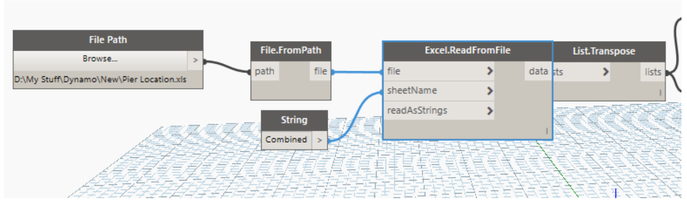
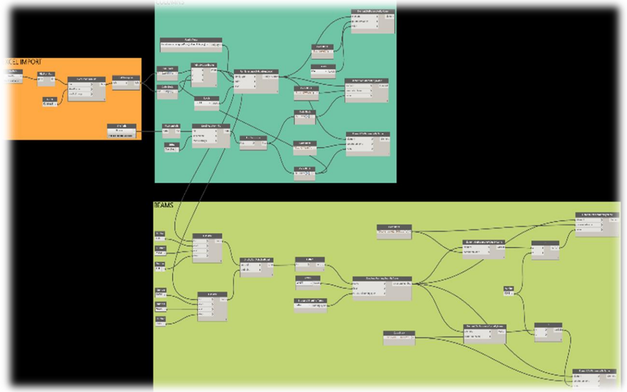
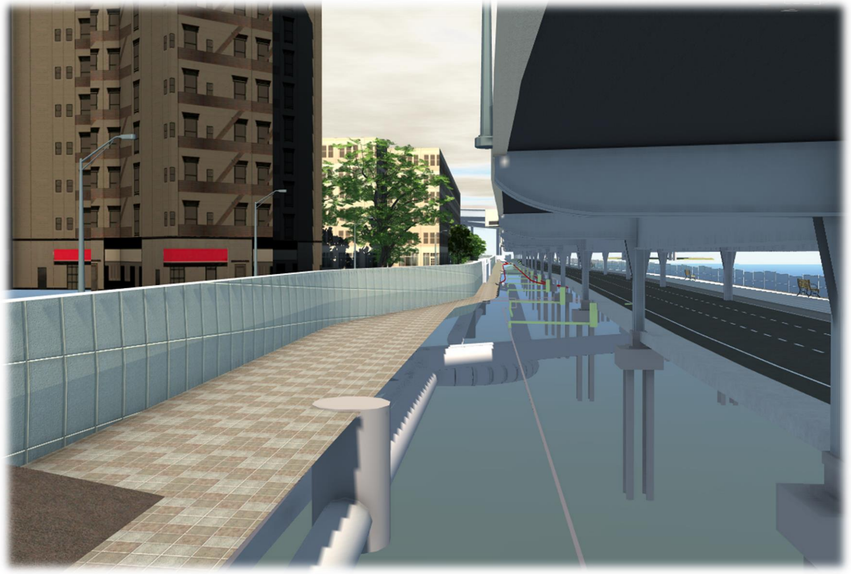
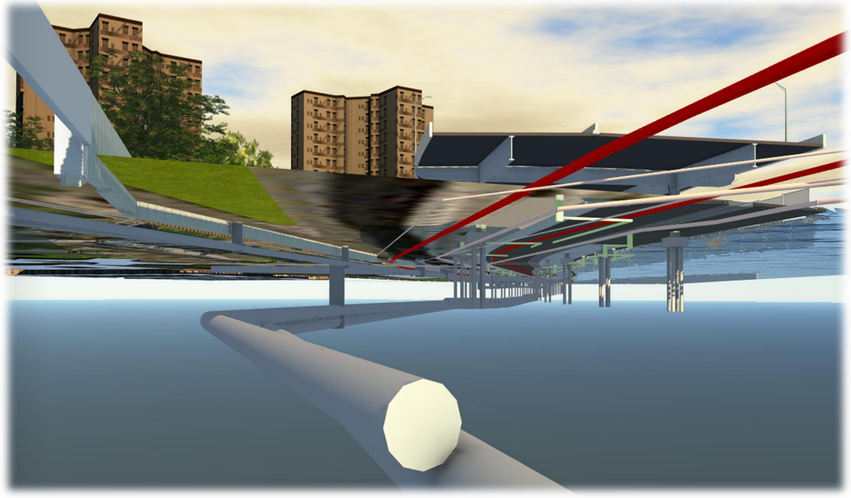
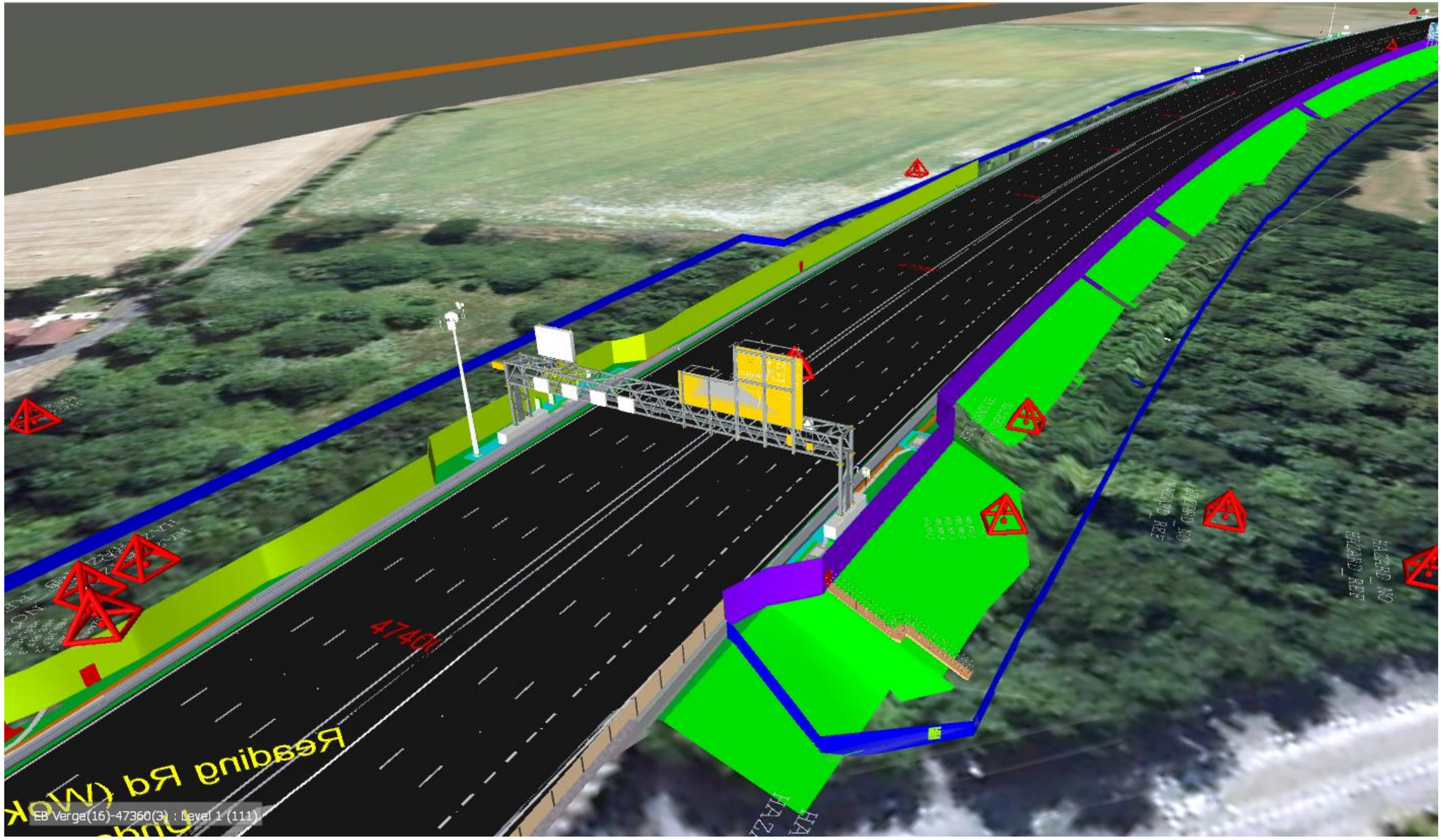
parameterName
var[]..[]


File Path
Browse...
D:\My Stuff\Dynamo\New\Pier Location.xls
File.FromPath
path
file
Excel.ReadFromFile
file
sheetName
readAsStrings
data
List.Transpose
lists
lists
String
Combined


EXCEL IMPORT
BEAMS






EB Verge(16)-47360(3) : Level 1 (111)

```vb
<CommandMethod("SMP_CreateCorridorFromPolyline")> _
Public Sub CreateCorridorFromPolyline()
    Try
        ' Get the Civil Object
        GetCivilObject()
        m_trans = m_Database.TransactionManager.StartTrans

        ' create the Civil 3D Site Object
        CreateSite()

        '' Ask for the Alignment Name

        Dim pStrOpts As PromptStringOptions = New PromptStringOption
        pStrOpts.AllowSpaces = True
        Dim pStrRes As PromptResult = ed.GetString(pStrOpts)

        Application.ShowAlertDialog("The Alignment name entered was  : " +

        Dim ALIGNMENT_NAME As String = pStrRes.StringResult
        Dim iCounter As Integer = 0


        '' Select the Surface Object

        Dim selSurface As PromptEntityOptions = New PromptEntityOptions(vbCrLf + "Sel
        selSurface.SetRejectMessage(vbCrLf + "Only Civil 3D Surface Object is allowed
        selSurface.AddAllowedClass(GetType(Autodesk.Civil.DatabaseServices.TinSurface),
        Dim resSurface As PromptEntityResult = ed.GetEntity(selSurface)

        If resSurface.Status <> PromptStatus.OK Then

            ed.WriteMessage("Problem in Surface Selection, Exiting! Try Again !")

            Exit Sub

        End If
```

1
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Profile - Kerb - 0
Views
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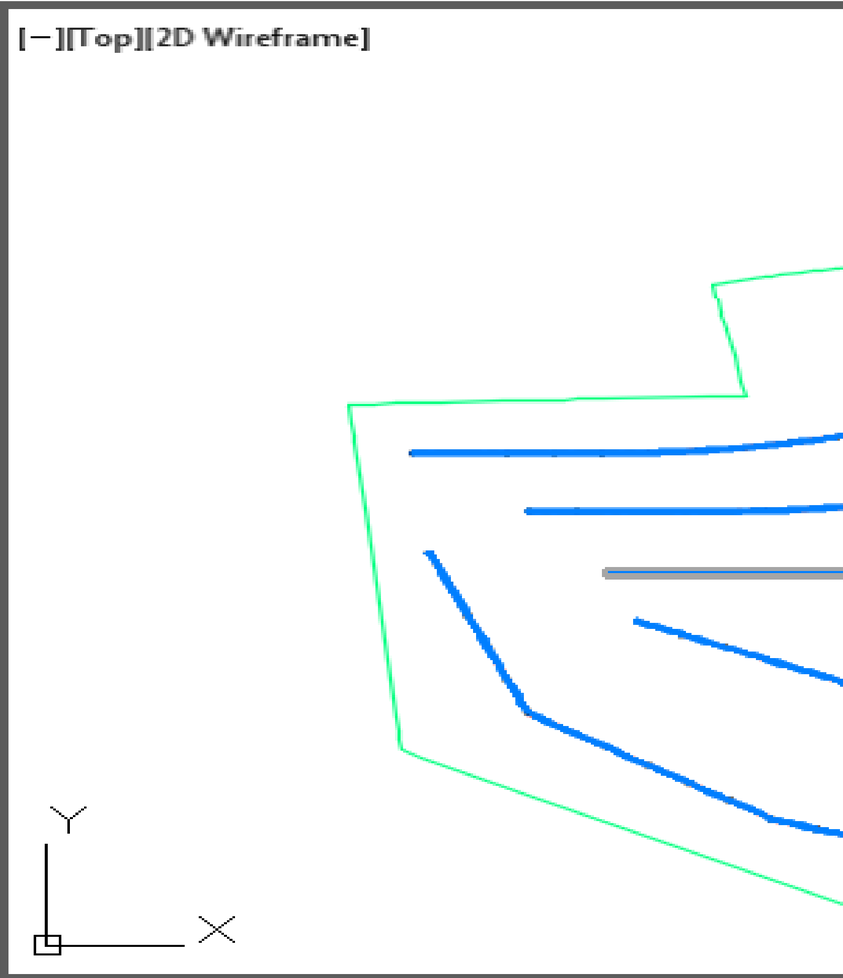
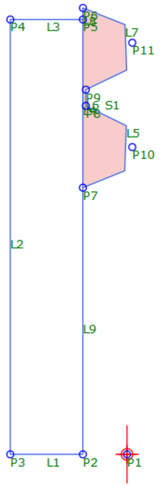
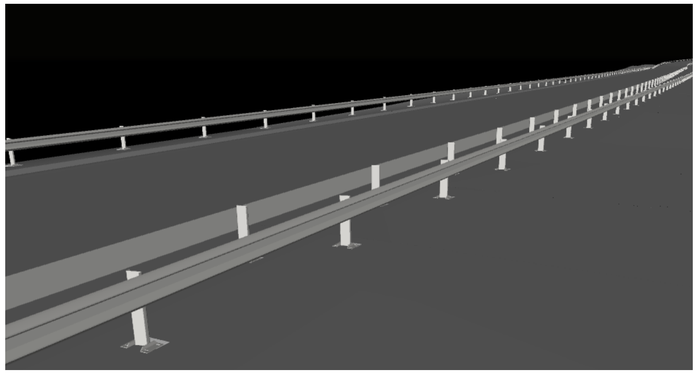
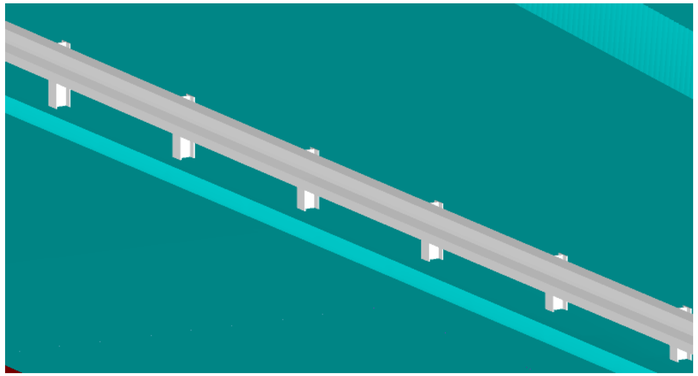
Prospector
Settings
Survey
Toolbox

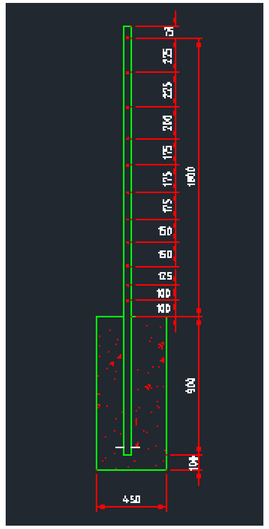



```
AutoCAD menu utilities loaded.*Cancel*
Command:
Autodesk DWG.  This file is a TrustedDW
Command:
Command: NETLOAD
Initializing the ARCADIS© Custom Tool !
Custom command named ## SMP_CreateCorri
Command: SMP_CREATECORRIDORFROMPOLYLINE
Type in the Alignment Name: Kerb
Select the Civil 3D Surface to be used
Select the Civil 3D Assembly to be used
Select the Polyline Objects: Specify op
Select the Polyline Objects:
```


P4
L3
P5
L7
P11
P9
P6
S1
P8
L5
P10
P7
L2
L9
P3
L1
P2
P1






75
425
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900
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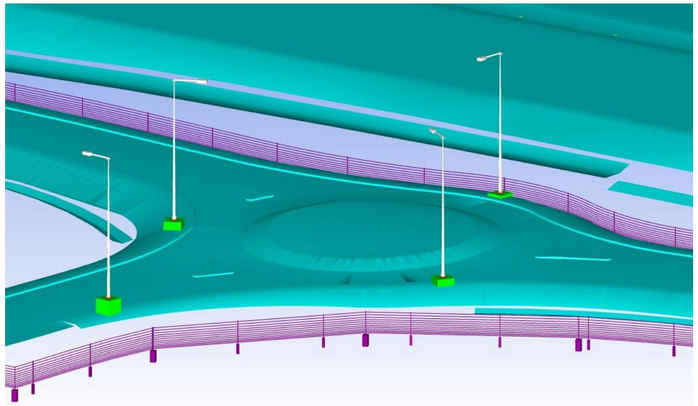
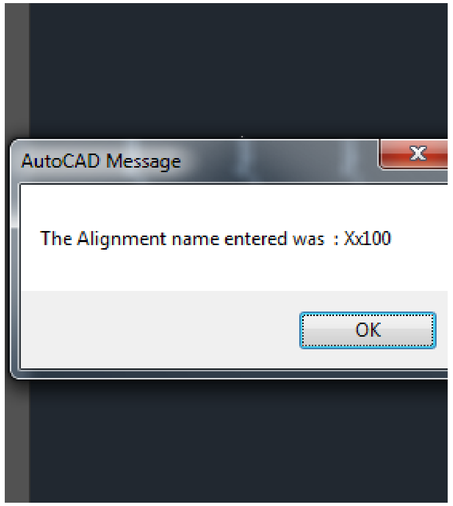
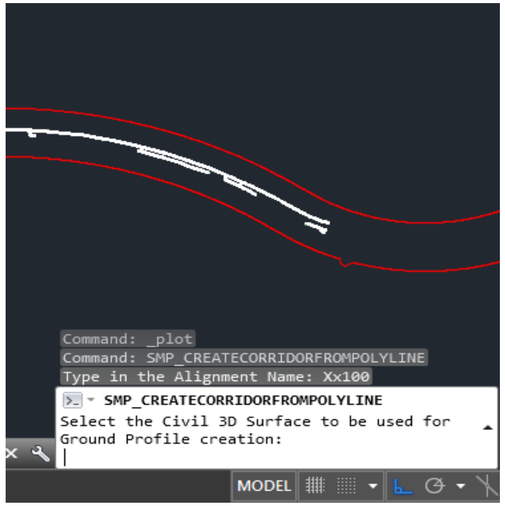
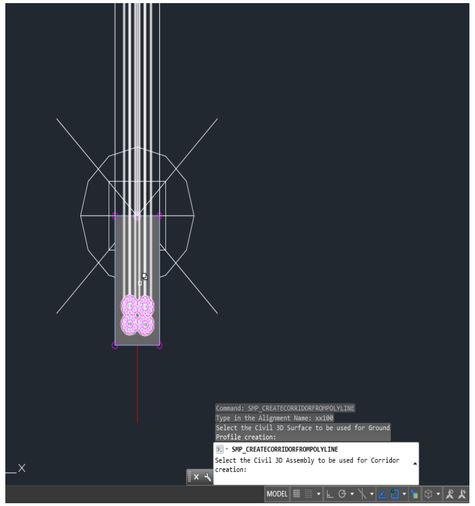
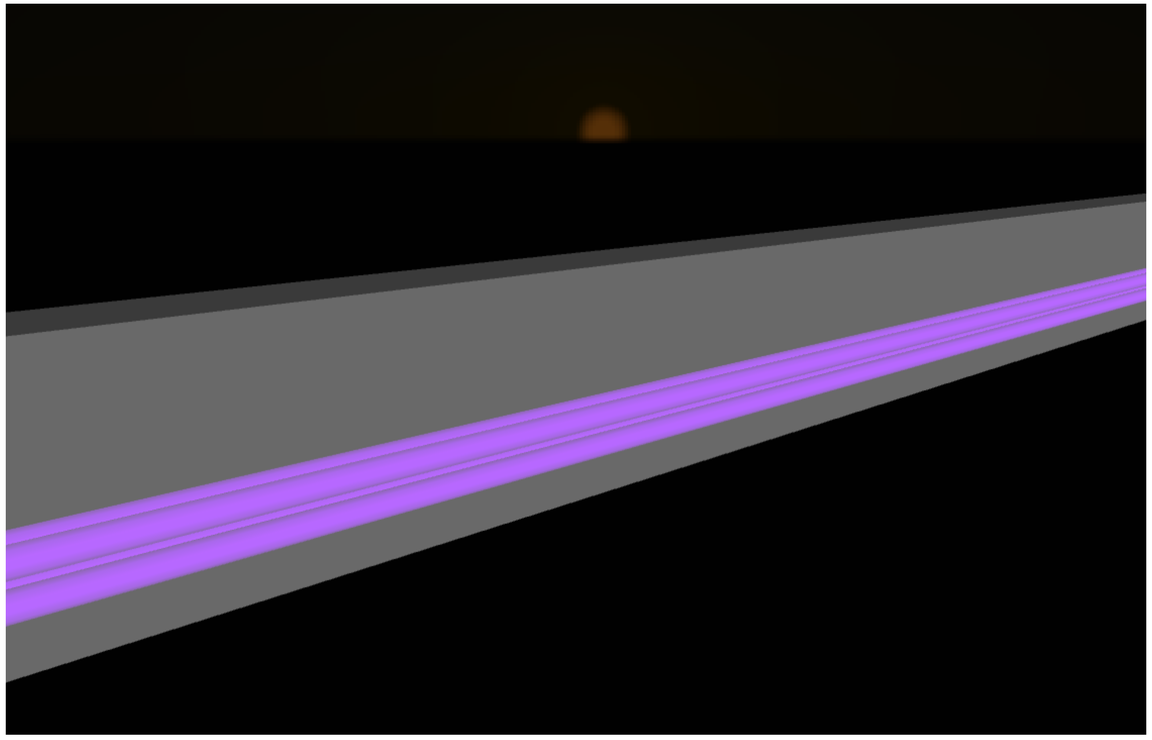
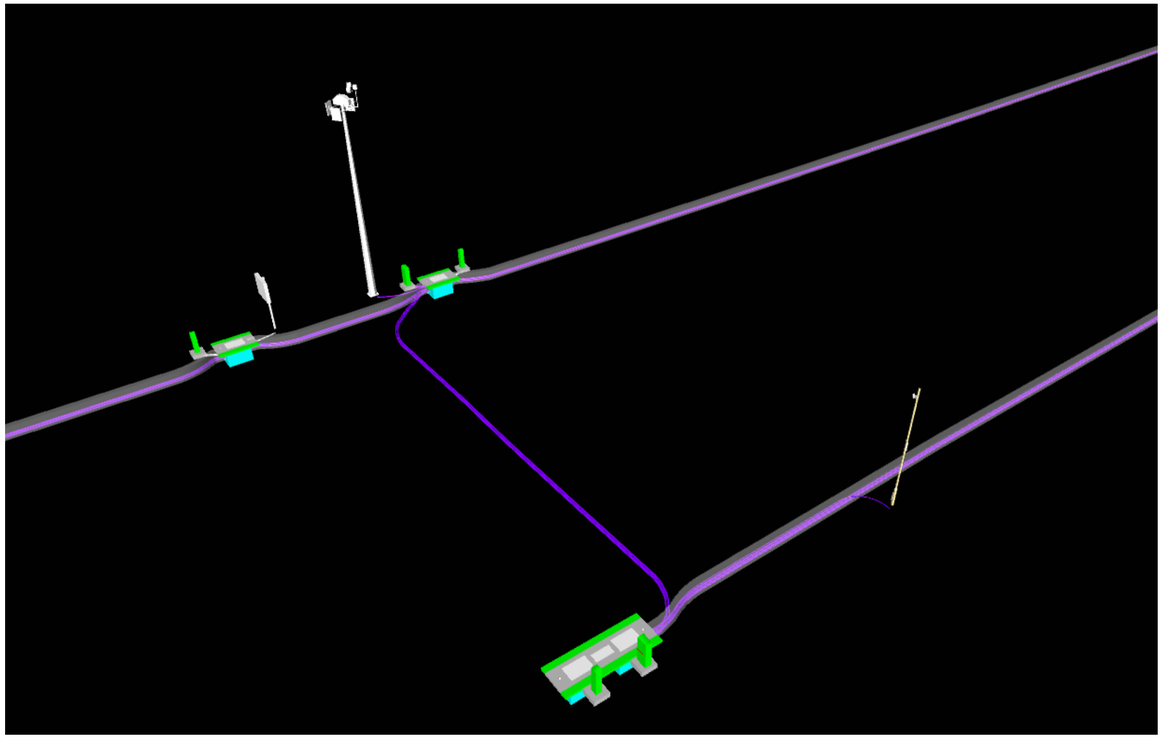


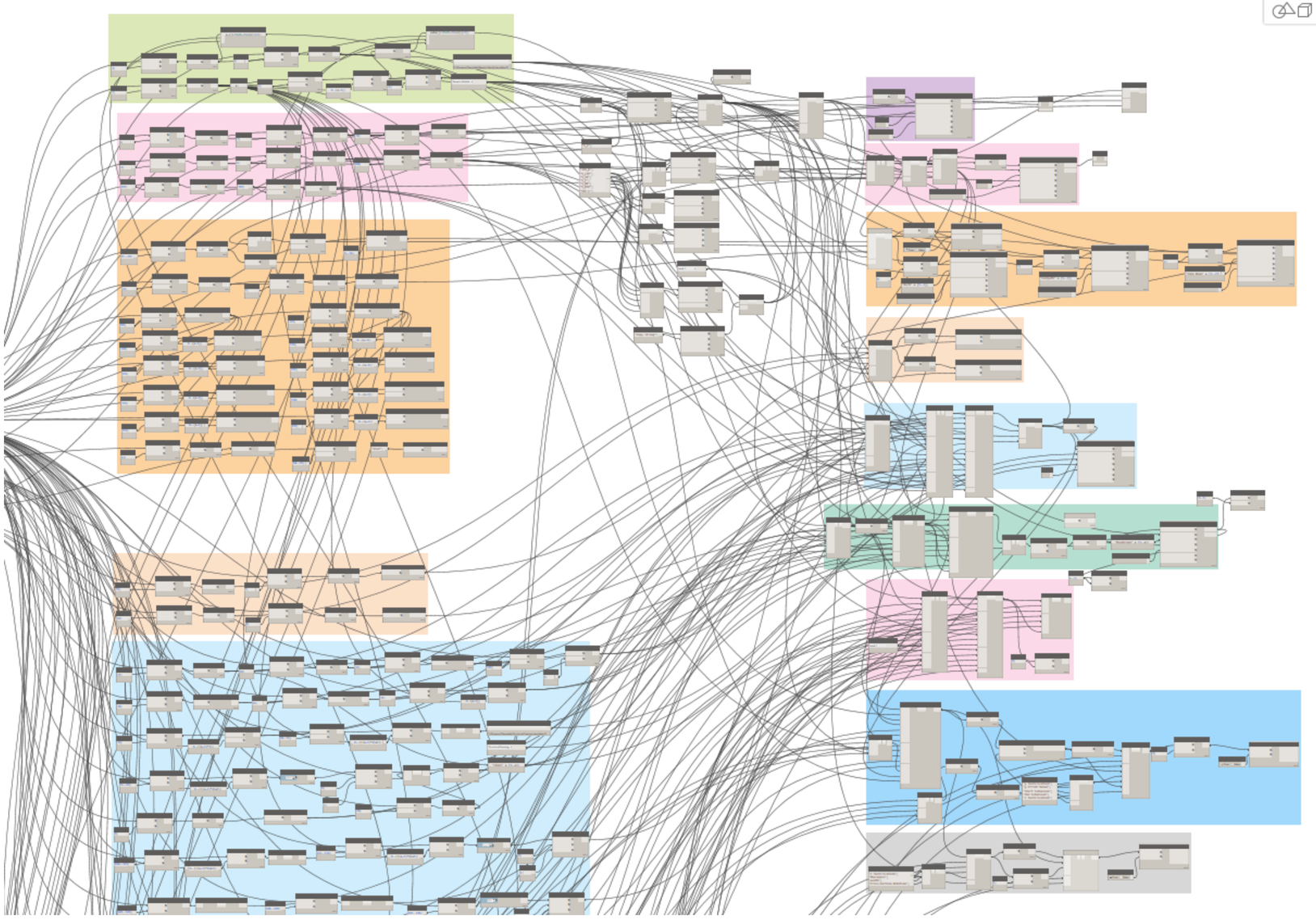

AutoCAD Message
The Alignment name entered was : Xx100
OK

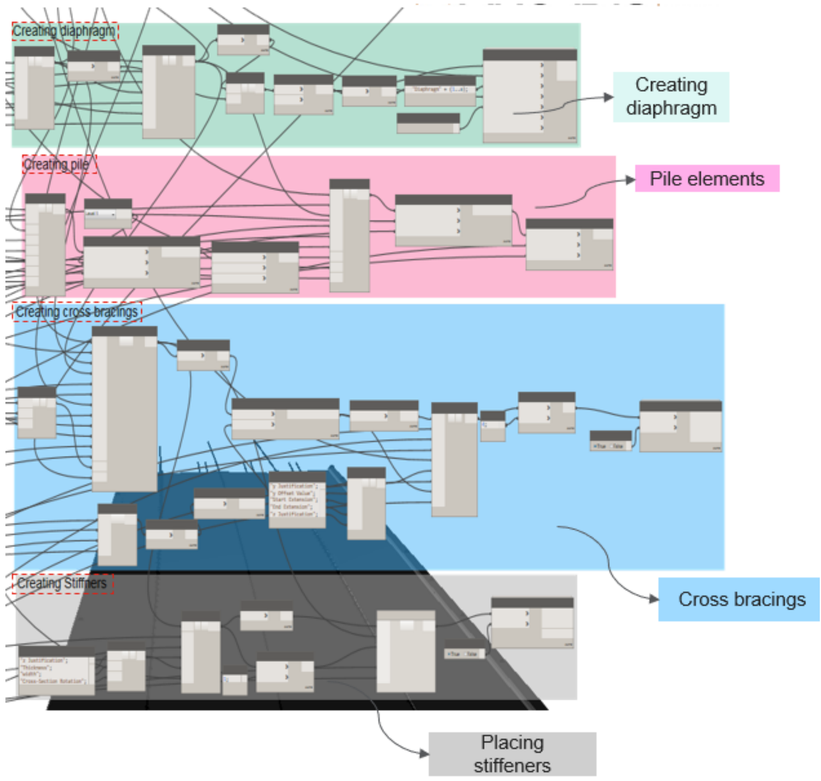

Command: _plot
Command: SMP_CREATECORRIDORFROMPOLYLINE
Type in the Alignment Name: Xx100
SMP_CREATECORRIDORFROMPOLYLINE
Select the Civil 3D Surface to be used for Ground Profile creation:
MODEL

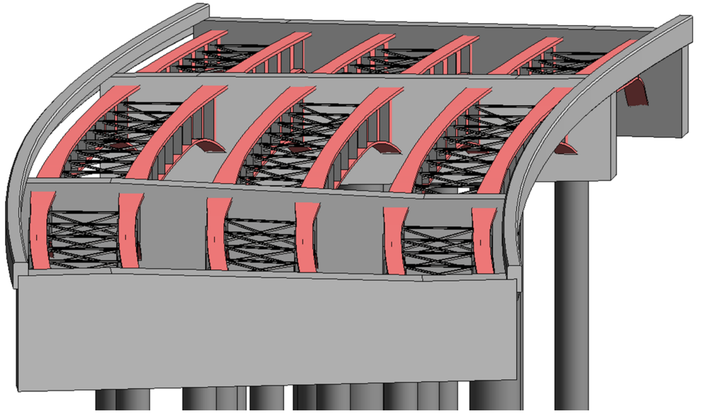




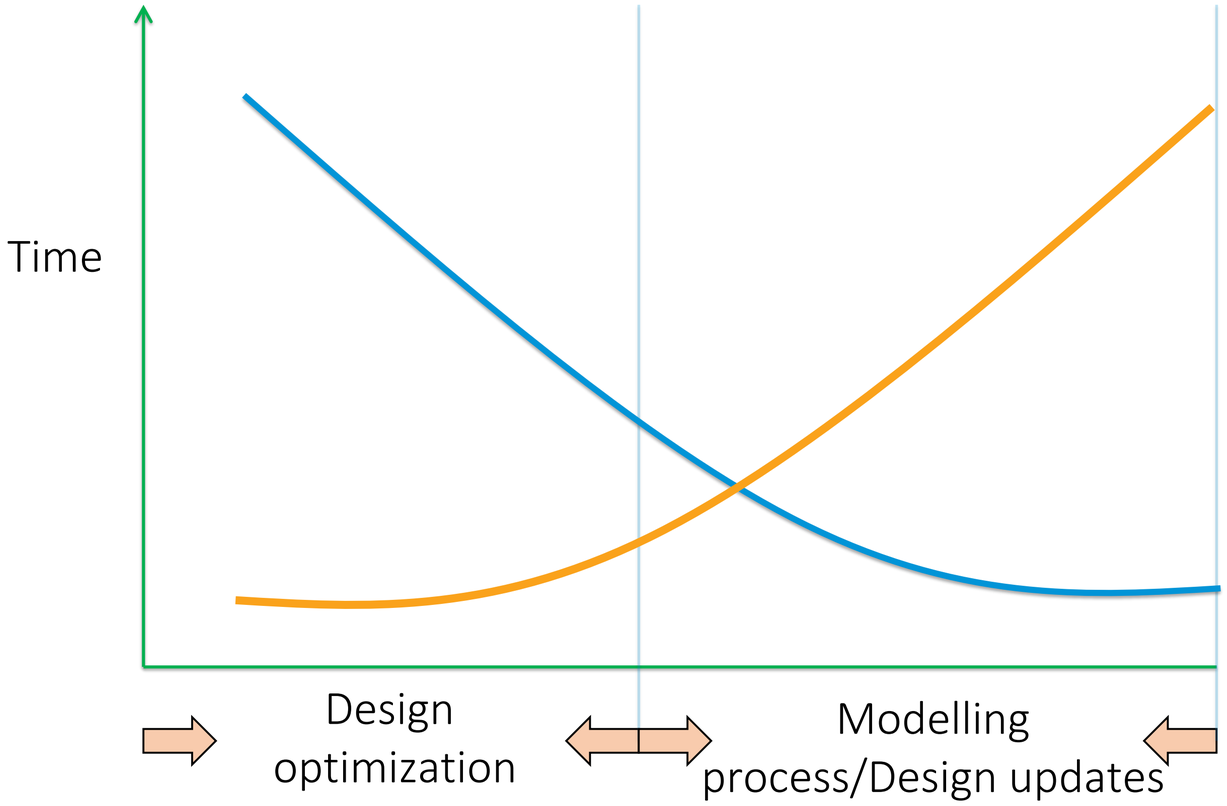


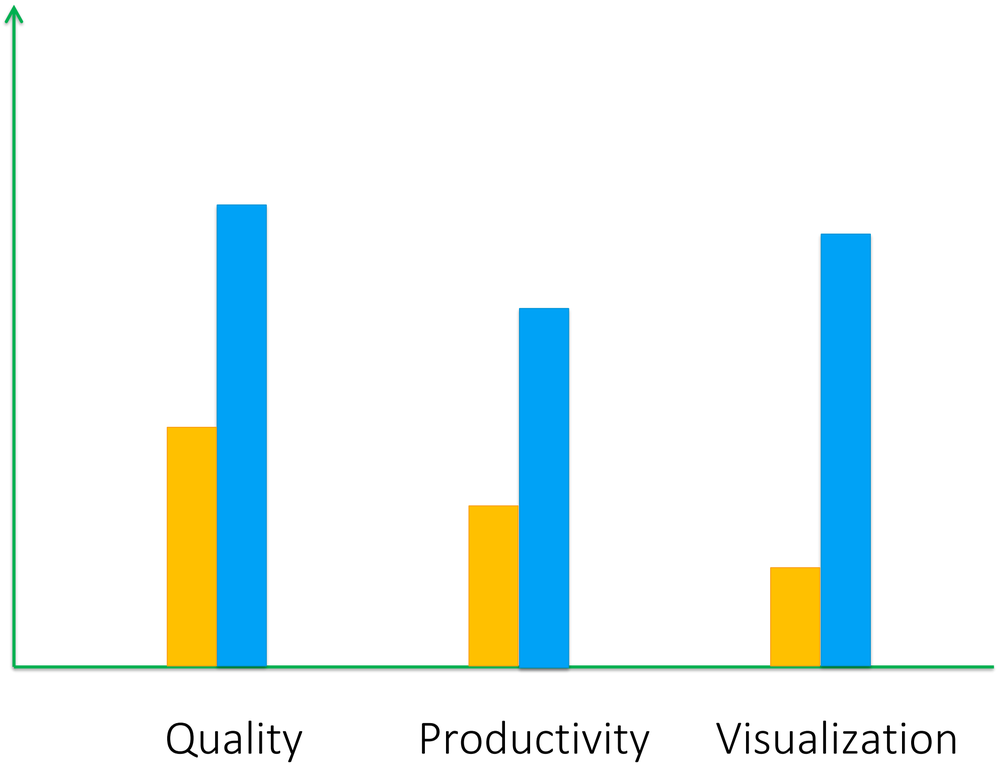



Creating diaphragm
Creating diaphragm
Creating pile
Pile elements
Creating cross-bracings
Cross bracings
Creating Stiffners
Placing stiffeners



Comparison between “with & with-out” Automation Workflow



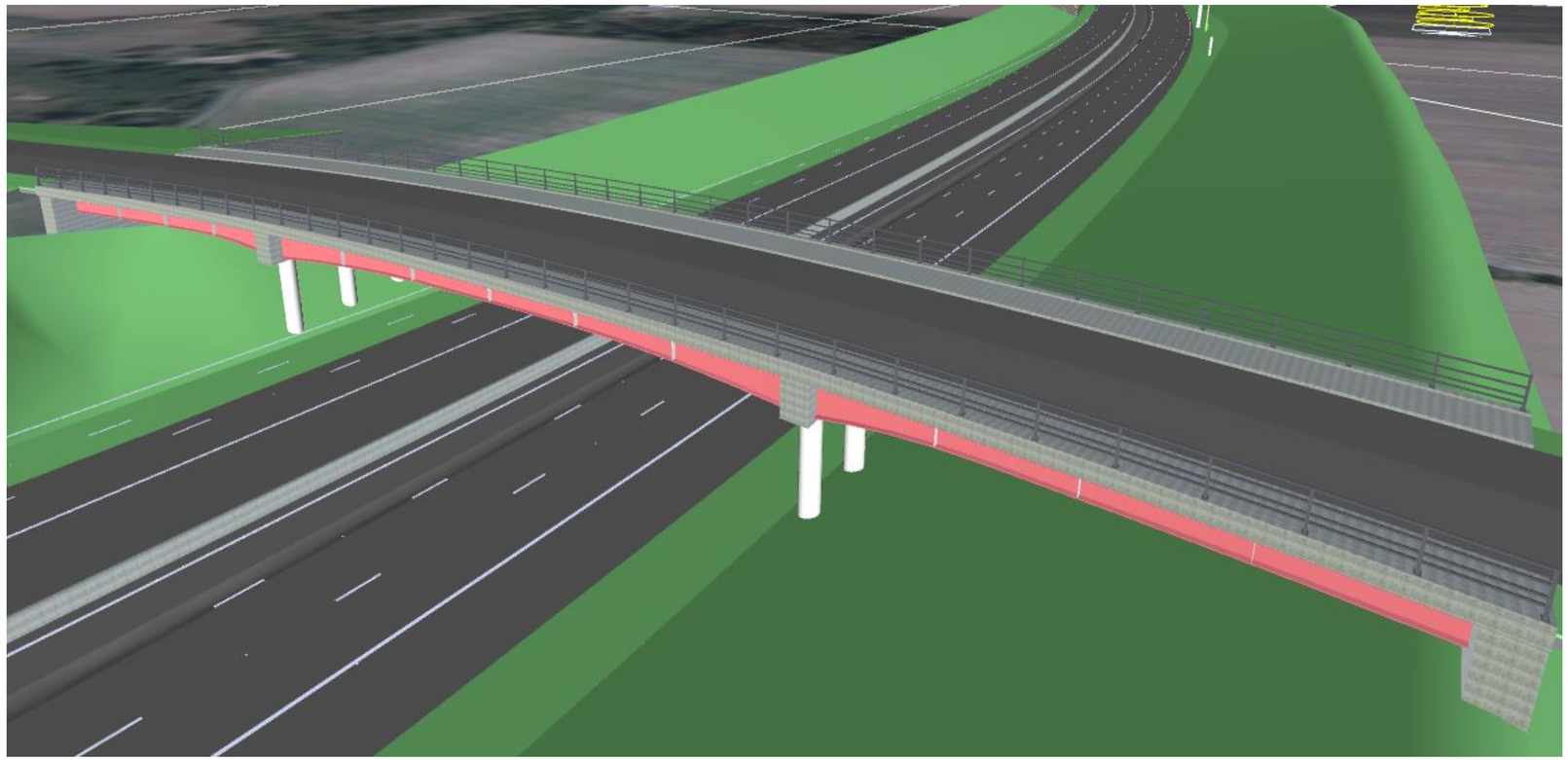


With-out automation

With automation

Challenges Associated with Bridge Modelling

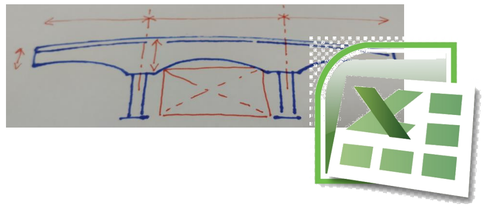
- Generating complex geometry directly in Revit
- Ability to adapt to design/location change of the structure
- Generating quick Revit model for concept visualizations
- Managing asset data
- Time consuming for large scale projects
- Manual process is error prone



Traditional Workflow for Model Production

Disconnected Data Sources

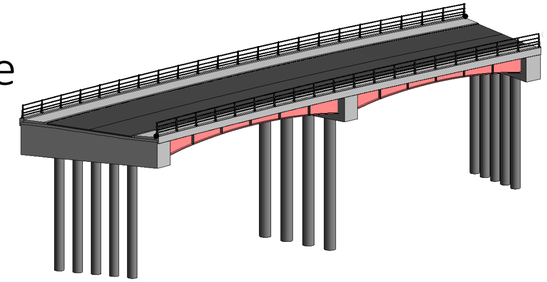
Highway alignment



Design Information

Manual Model Production

Revit model generated manually to comply with structural design information and alignment information. Can include parametric families where possible.

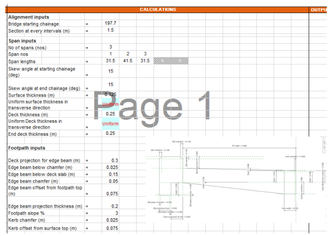


Automated Workflow for Model Production

Design Template – User Interface

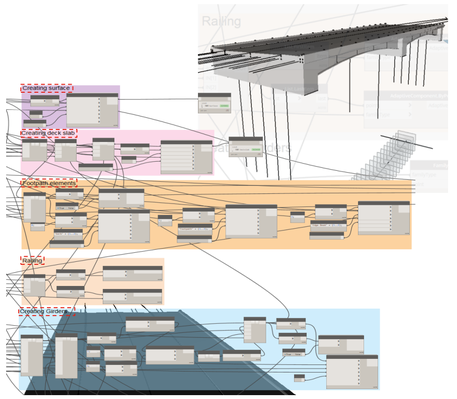
Auto Prelim Design

Highway Alignment



Design Interface (Parameters)

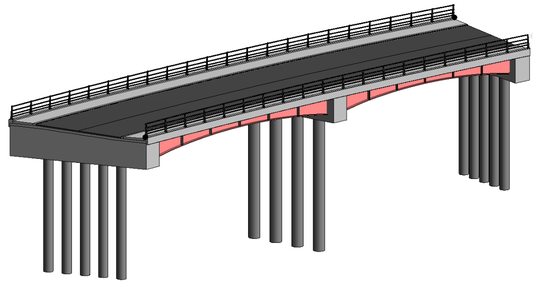
Dynamo



Automated Model Production

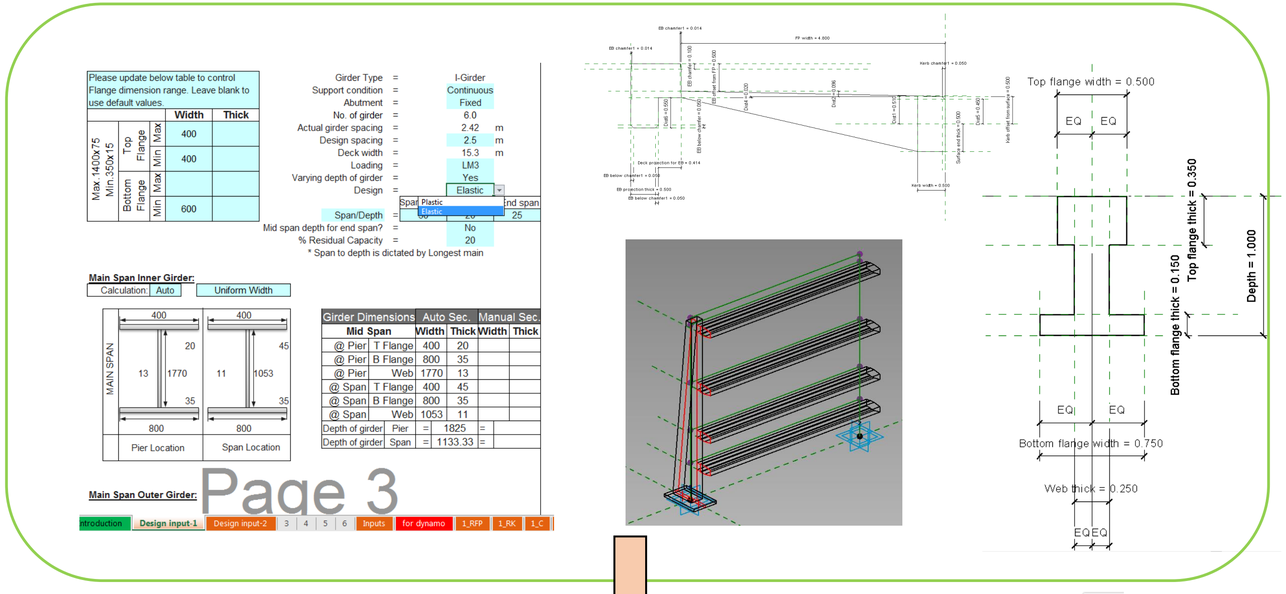
Revit Families

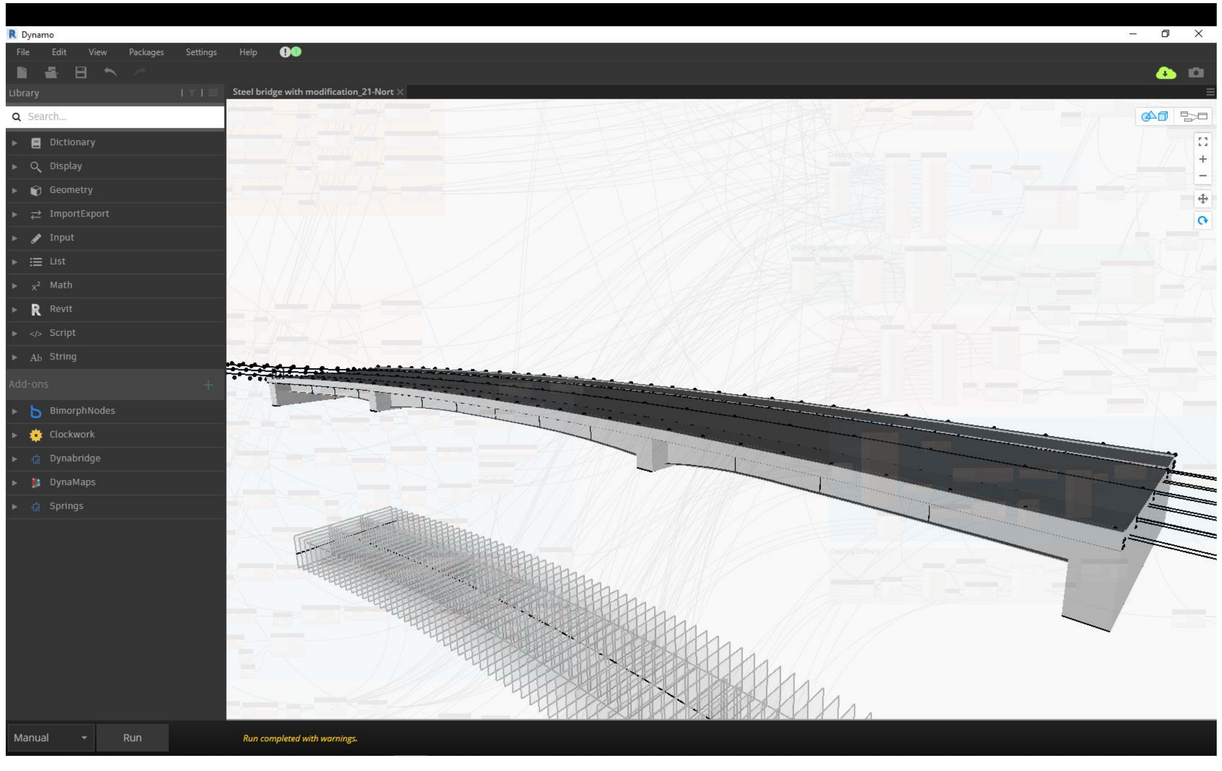
Asset Data

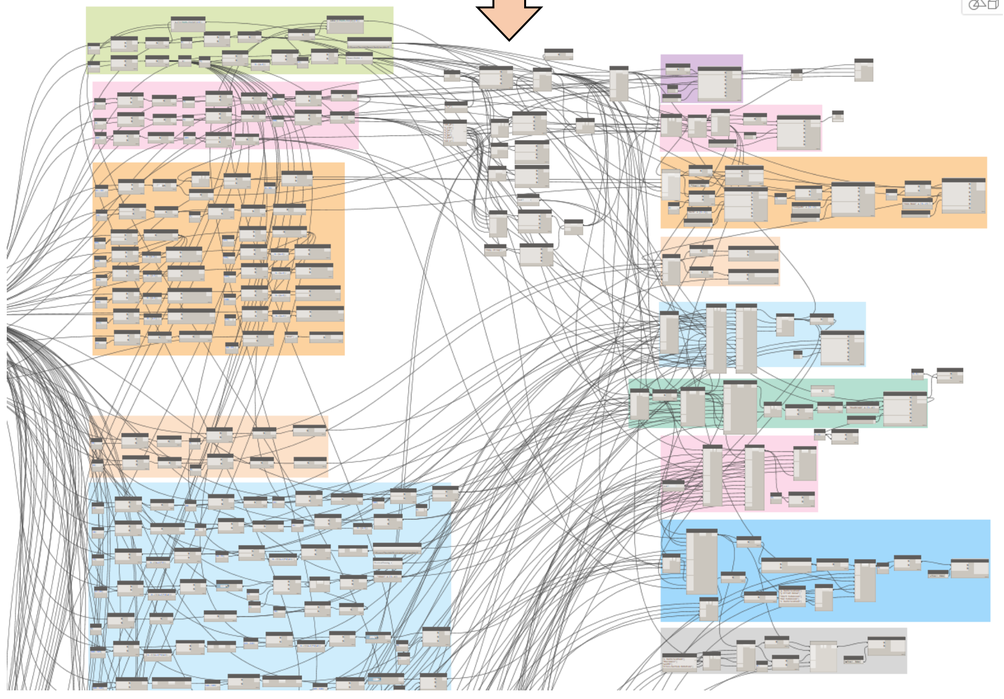


Revit / Dynamo Modelling Functions for Multi-span Bridge

- User design excel interface with various input for design parameters and semi-automation of section sizing
- Necessary inputs are read from the front end user interface
- Dynamo “definitions & Python” are used to generate complex geometries and imported to the Revit project as families
- Parametric families are also used for the model generation for non complex geometries
- Any changes like span length, skews, bracing options, bridge location, etc., update the user interface excel and model will be updated



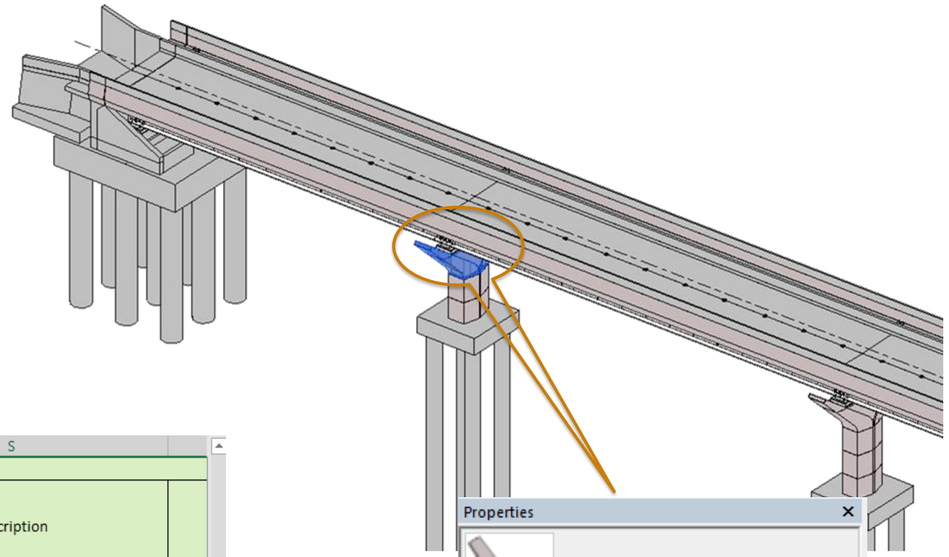





ARCADIS
Design & Consultancy
for natural and
built assets

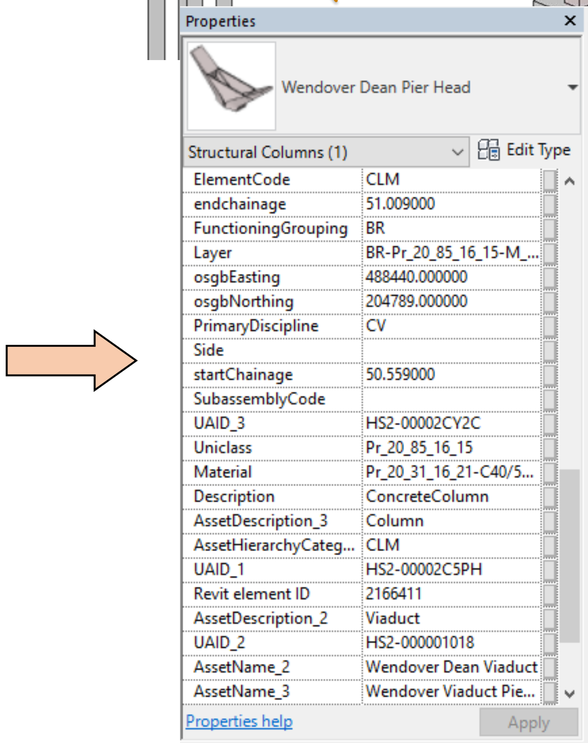
Asset Data Management

- Asset data and necessary attributes controlled in front end user interface in accordance with Client Requirements.
- Additional asset data parameters generated in Revit as various parameters
- Attributes populated automatically using Dynamo in a two way process from excel to Revit and back out into required database



	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	S
1											Classification codes				Level Naming Procedure		
2	Asset Name	Asset Hierarchy Category	Asset Description	UAID_3	UAID_2	Uniclass 2015	Start Chainage	End Chainage	OSGB Easting	OSGB Northing	Primary discipline	Functional grouping	Primary Asset	Element Code	Discipline	Classification	Description
200	Wendover Viaduct	CLM	Column	HS2-00002CY2C	HS2-000001018	Pr_20_85_16_15	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Pr_20_85_16_15	ConcreteColumn
201	Wendover Viaduct	CLM	Column	HS2-00002CY2D	HS2-000001018	Pr_20_85_16_15	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Pr_20_85_16_15	ConcreteColumn
202	Wendover Viaduct	CLM	Column	HS2-00002CY2E	HS2-000001018	Pr_20_85_16_15	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Pr_20_85_16_15	ConcreteColumn
203	Wendover Viaduct	CLM	Column	HS2-00002CY2F	HS2-000001018	Ss_20_50_20_70	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Ss_20_50_20_70	ReinforcedConcreteBridgePier
204	Wendover Viaduct	CLM	Column	HS2-00002CY2G	HS2-000001018	Ss_20_30_75_15	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Ss_20_30_75_15	ConcreteColumn
205	Wendover Viaduct	CLM	Column	HS2-00002CY2H	HS2-000001018	Ss_20_30_75_15	50.559	51.009	488440	204789	CV	BR	VD	CLM	BR	Ss_20_30_75_15	ConcreteColumn
206	Wendover Viaduct	BER	Bearings	HS2-00002CY2J	HS2-000001018	Pr_20_85_10	50.559	51.009	488440	204789	CV	BR	VD	BER	BR	Pr_20_85_10	BridgeBearing
207	Wendover Viaduct	BER	Bearings	HS2-00002CY2K	HS2-000001018	Pr_20_85_10	50.559	51.009	488440	204789	CV	BR	VD	BER	BR	Pr_20_85_10	BridgeBearing
208	Wendover Viaduct	BEM	Beam	HS2-00002CY2L	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
209	Wendover Viaduct	BEM	Beam	HS2-00002CY2M	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
210	Wendover Viaduct	BEM	Beam	HS2-00002CY2N	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
211	Wendover Viaduct	BEM	Beam	HS2-00002CY2P	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
212	Wendover Viaduct	BEM	Beam	HS2-00002CY2Q	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
213	Wendover Viaduct	BEM	Beam	HS2-00002CY2R	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
214	Wendover Viaduct	BEM	Beam	HS2-00002CY2S	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
215	Wendover Viaduct	BEM	Beam	HS2-00002CY2T	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
216	Wendover Viaduct	BEM	Beam	HS2-00002CY2U	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
217	Wendover Viaduct	BEM	Beam	HS2-00002CY2V	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
218	Wendover Viaduct	BEM	Beam	HS2-00002CY2W	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
219	Wendover Viaduct	BEM	Beam	HS2-00002CY2X	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
220	Wendover Viaduct	BEM	Beam	HS2-00002CY2Y	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
221	Wendover Viaduct	BEM	Beam	HS2-00002CY2Z	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
222	Wendover Viaduct	BEM	Beam	HS2-00002CY30	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
223	Wendover Viaduct	BEM	Beam	HS2-00002CY31	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
224	Wendover Viaduct	BEM	Beam	HS2-00002CY32	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
225	Wendover Viaduct	BEM	Beam	HS2-00002CY33	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
226	Wendover Viaduct	BEM	Beam	HS2-00002CY34	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
227	Wendover Viaduct	BEM	Beam	HS2-00002CY35	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
228	Wendover Viaduct	BEM	Beam	HS2-00002CY36	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
229	Wendover Viaduct	BEM	Beam	HS2-00002CY37	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
230	Wendover Viaduct	BEM	Beam	HS2-00002CY38	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam
231	Wendover Viaduct	BEM	Beam	HS2-00002CY39	HS2-000001018	Ss_20_20_75_80	50.559	51.009	488440	204789	CV	BR	VD	BEM	BR	Ss_20_20_75_80	SteelBeam

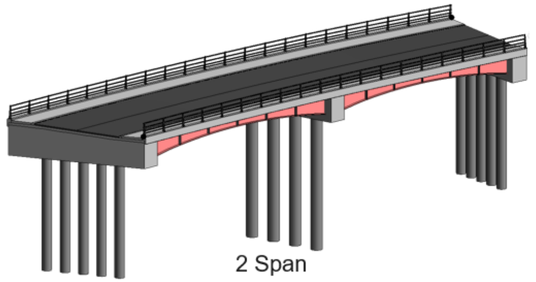
Cover Sheet | MPDT Element of Asset | 1MC07-CEK-IM-LST-C003-700001 | att_matrix

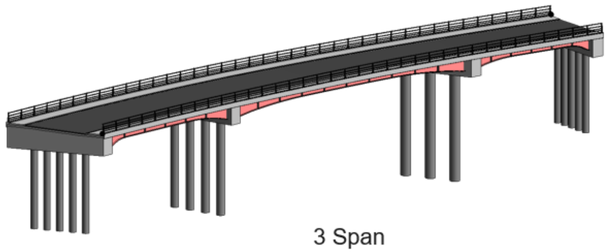


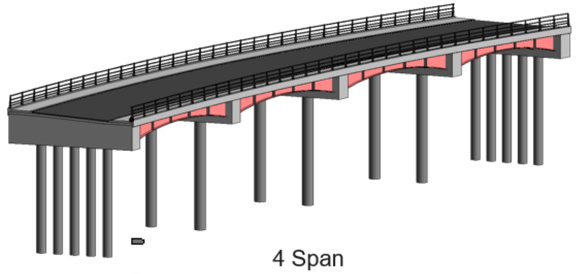
Asset data

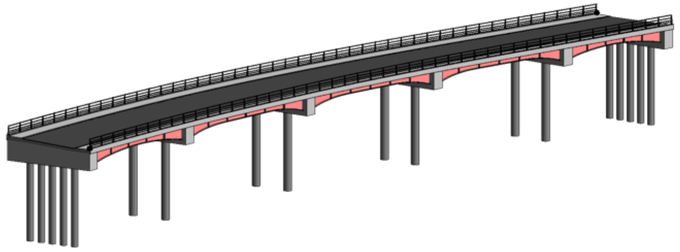
Flexibility of the Automation Tool & Work Flow

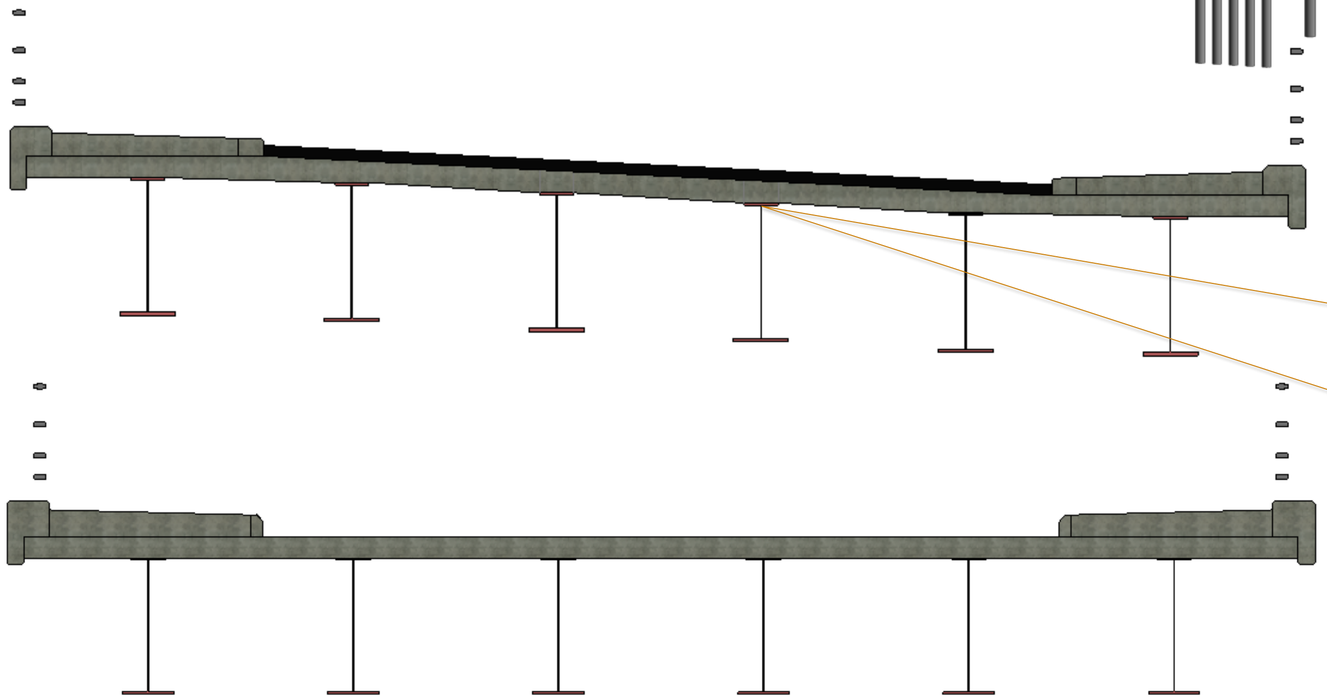
- Any span length with any number of spans
- Can accommodate any highway profiles
- All controlled through standardised front-end user interface
- Can control different skew angles for each abutment/pier
- Uniform/varying surface & deck slab can be formed.
- Deck soffit will be aligned with girder top flanges

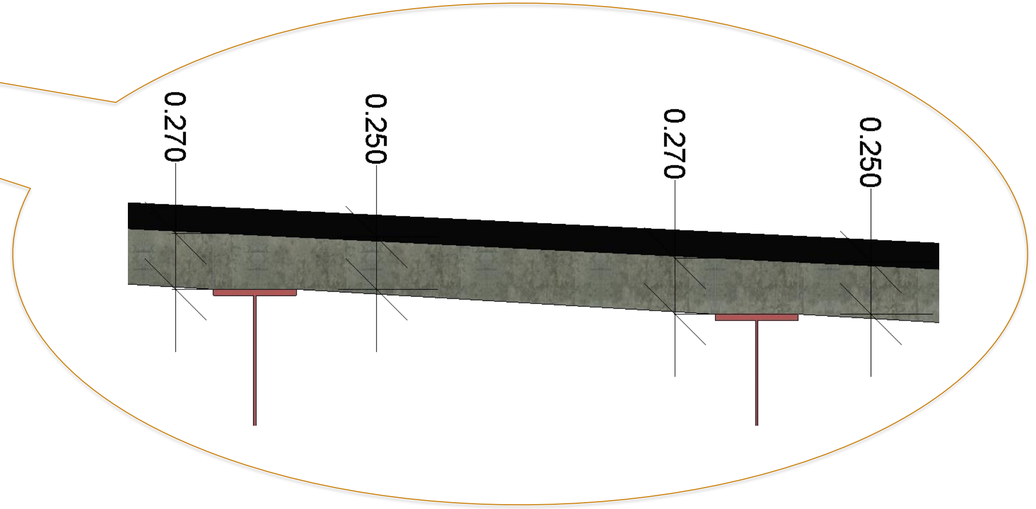






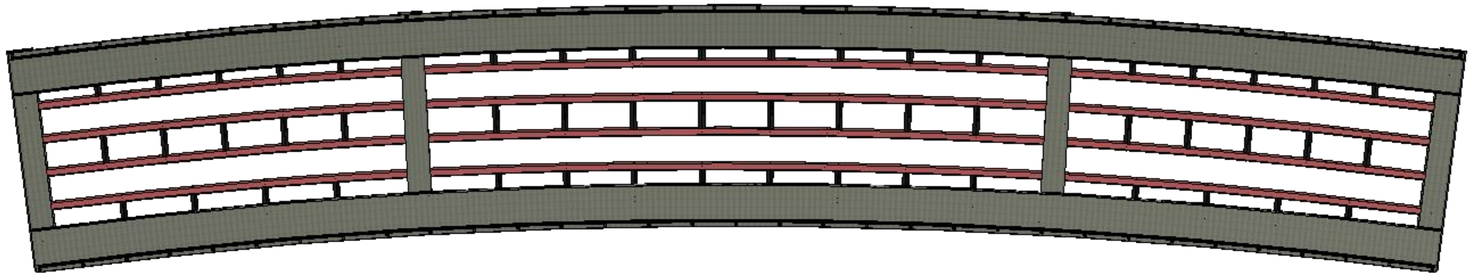


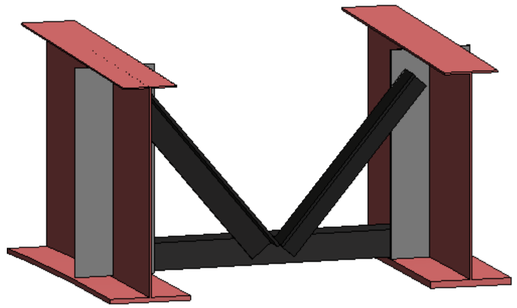


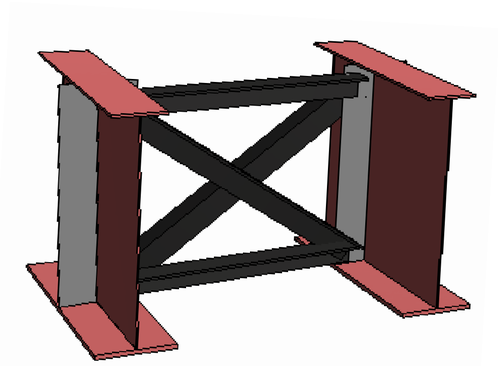


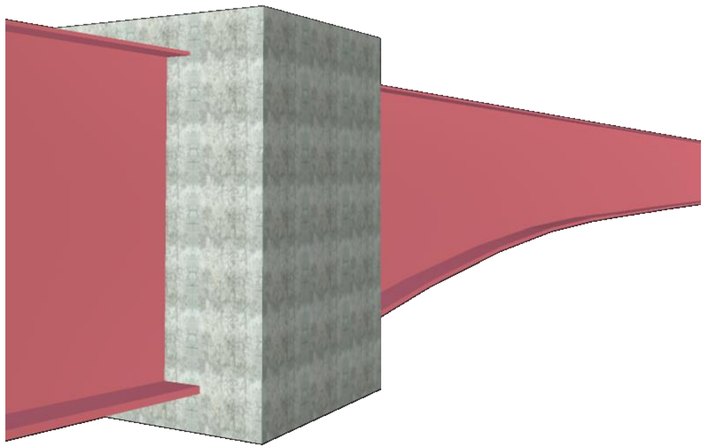
Flexibility of the Automation Tool & Work Flow (cont'd)

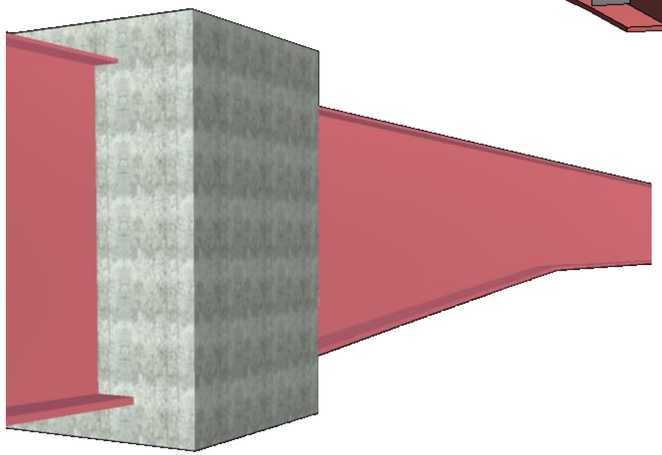
- Girders and deck can be modelled with plan and vertical curvature, aligned with highway
- Girder dimensions can vary along the span
- Different types of bracings can be selected
- Parabolic/linear girder soffit profiling can be achieved
- Bracing spacing can be automatically adjusted for varying beam lengths in a span
- Bracing angle locations can be automatically adjusted for varying beam depths in a span

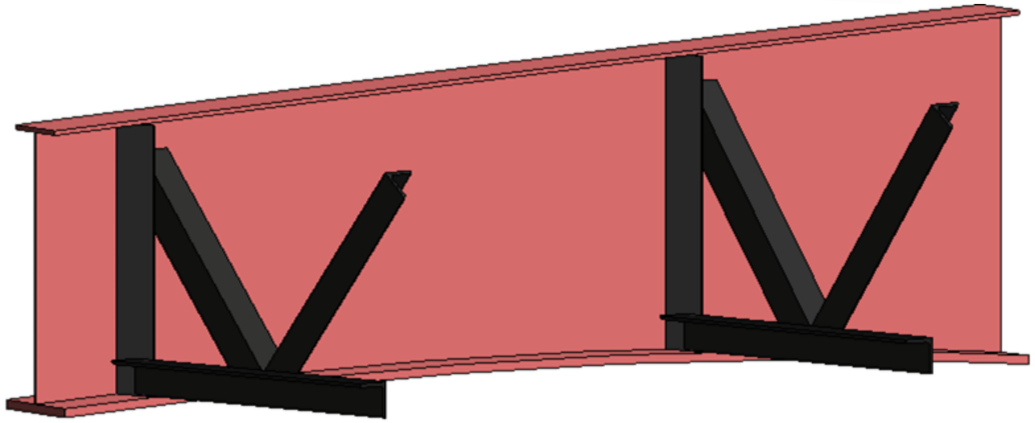






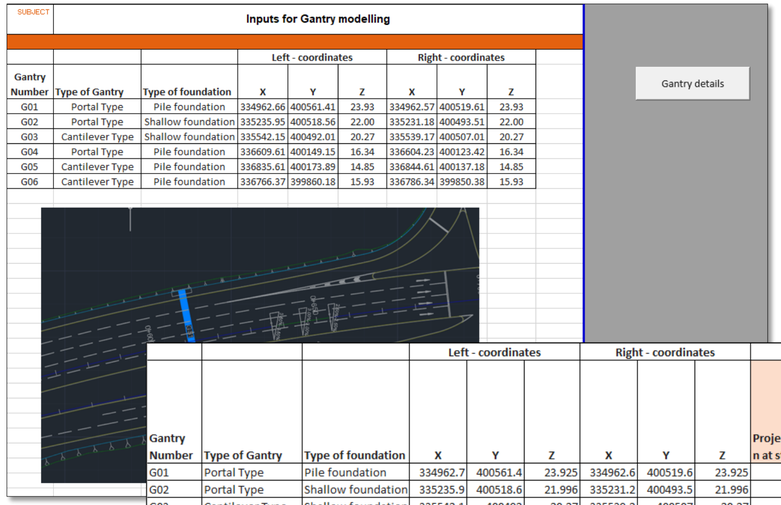






Revit / Dynamo Modelling Functions for Gantries

- User design excel interface with various input like gantry types, foundation types, coordinates etc.,
- Parametric families are used for the model generation
- Dynamo “definitions & Python” are used to placing families within the Revit project at exact coordinates
- Multiple parameters can be then edited in Revit Family
- Number of gantries can be created in the Revit model more efficiently using automation.

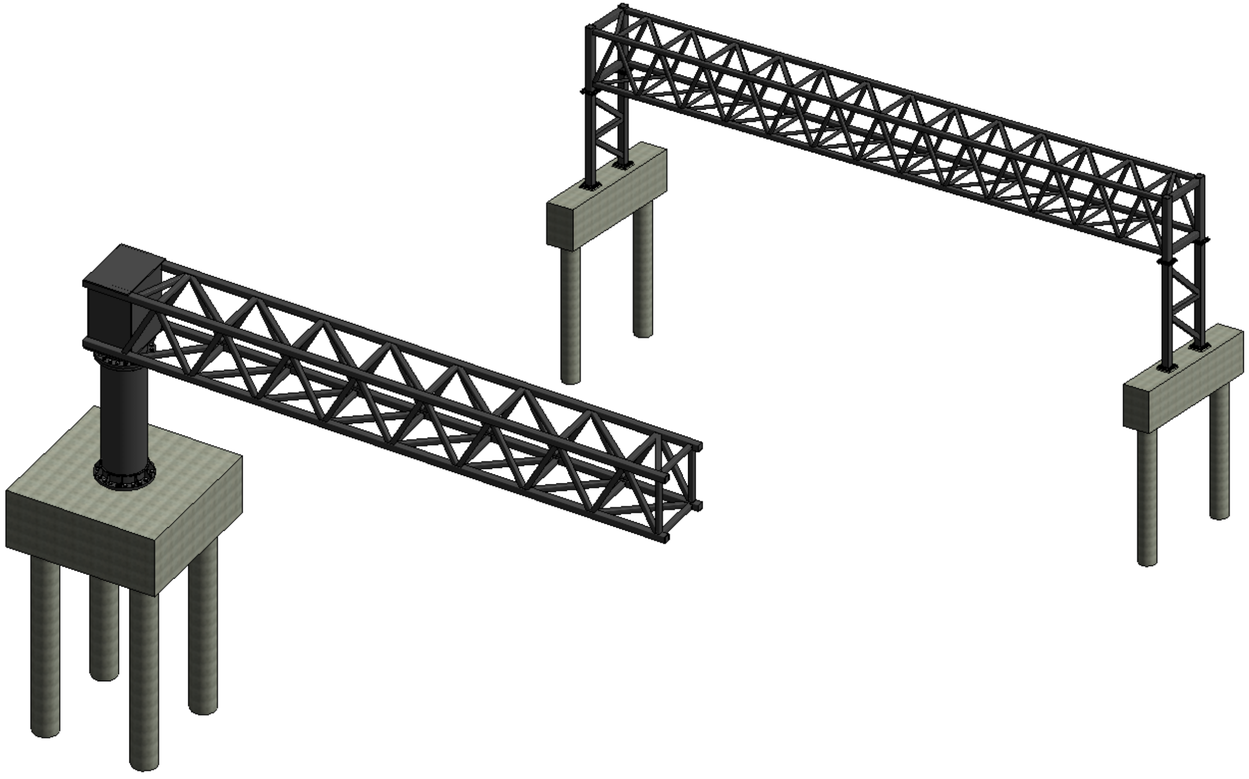

SUBJECT

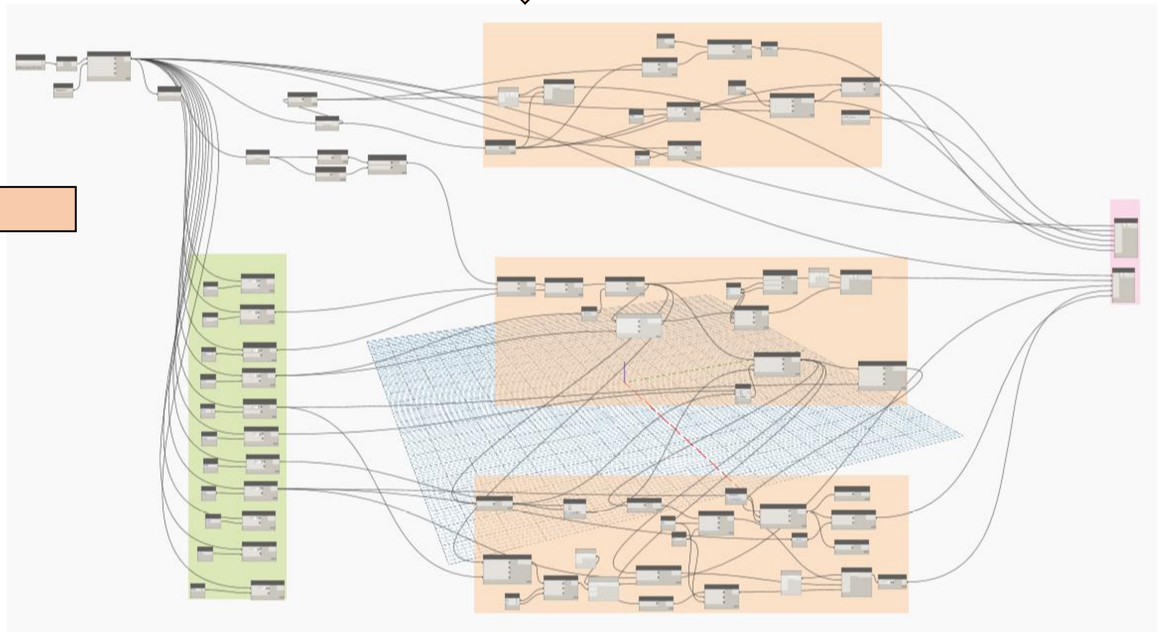
Inputs for Gantry modelling

Gantry Number	Type of Gantry	Type of foundation	Left - coordinates X	Left - coordinates Y	Left - coordinates Z	Right - coordinates X	Right - coordinates Y	Right - coordinates Z
G01	Portal Type	Pile foundation	334962.66	400561.41	23.93	334962.57	400519.61	23.93
G02	Portal Type	Shallow foundation	335235.95	400518.56	22.00	335231.18	400493.51	22.00
G03	Cantilever Type	Shallow foundation	335542.15	400492.01	20.27	335539.17	400507.01	20.27
G04	Portal Type	Pile foundation	336609.61	400149.15	16.34	336604.23	400123.42	16.34
G05	Cantilever Type	Pile foundation	336835.61	400173.89	14.85	336844.61	400137.18	14.85
G06	Cantilever Type	Pile foundation	336766.37	399860.18	15.93	336786.34	399850.38	15.93

Gantry details

Gantry Number	Type of Gantry	Type of foundation	Left - coordinates X	Left - coordinates Y	Left - coordinates Z	Right - coordinates X	Right - coordinates Y	Right - coordinates Z	Truss details: Projection at start	Projection at end	C/C of truss width	C/C of truss width	Diagnol bracing start offset	Diagnol bracing end offset	Number of bays in the bottom	Bottom offset from cetre	Top offset from cetre
G01	Portal Type	Pile foundation	334962.7	400561.4	23.925	334962.6	400519.6	23.925	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17
G02	Portal Type	Shallow foundation	335235.9	400518.6	21.996	335231.2	400493.5	21.996	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17
G03	Cantilever Type	Shallow foundation	335542.1	400492	20.27	335539.2	400507	20.27	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17
G04	Portal Type	Pile foundation	336609.6	400149.1	16.336		400123.4	16.336	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17
G05	Cantilever Type	Pile foundation	336835.6	400173.9	14.851		400137.2	14.851	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17
G06	Cantilever Type	Pile foundation	336766.4	399860.2	15.931		399850.4	15.931	0	0	2.25	2.25	0.15	0.15	13	0.31	0.17





Thank you all !

Q & A

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