

CI124452

Design Automation by Parametric Design of a Viaduct with Dynamo and Revit in 20 minutes

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Learning Objectives

- See how you can automate your designs for viaducts
- See how Dynamo helps reduce modeling time for repetitive tasks
- See an integrated design workflow between the physical and analytical model for a viaduct
- See how you can create custom interoperability with Dynamo, read specific AutoCAD Civil 3D information, and use this in Revit to model geometry

Description

Witness the automation of modeling a structural model for viaducts based upon an AutoCAD Civil 3D file, and exchange this with Microsoft Excel, Dynamo software, and Revit software. See how we use the analytical model for structural calculations in SOFiSTiK. The Revit model of a viaduct will contain pre-casted girders, concrete decks, abutments, pillars, foundation, piles, bearings, barriers, and railings. All of these elements will be generated in 20 minutes. We will use the typical design parameters like width, elevations, cross-fall (super elevation), amount of and length off spans, support rotation, and supports placed by station for this model. We will generate the Revit analytical model simultaneously to be used for structural analysis in SOFiSTiK. The content shown in this class was developed together with Autodesk Consulting, who taught us and helped us create the Visual Dynamo script with lots of Python nodes.

Speaker(s)**Michel Beliën****Revit & BIM specialist****Royal HaskoningDHV**

I am a structural engineer who has been focusing for many years on managing, standardizing and optimizing design software to enable us to be more efficient, effective and profitable in our way working. In recent years I have been made responsible for implementations and developments of applications that need to directly interface with Revit within Royal HaskoningDHV. Therefore we have started in the summer of 2016 looking for opportunities to automate design challenges by either parametric or computational design. I have a keen interest in staying up to date to latest industry trends and I investigate new technologies for their potential usage within the company. I am also actively involved in a Infrastructure User group in the Netherlands with many progressive minds in our field.

Paolo Serra**Implementation Consultant BIM****Autodesk**

I'm a construction engineer by trade, I worked as BIM Manager in an architectural firm for 5 years, now I am an Implementation Consultant BIM for Autodesk since 2014. With Autodesk I've been delivering Customer Success Services to engineering companies, supporting the BIM Transformation in their business processes. My main focuses are on automation, computational design, integration between AEC and ENI industries. Architecture enthusiast, Revit user since 2006, Autodesk products API and Dynamo knowledge seeker.

Table of Content

- Introduction of the business case, BIM Uses involved and expected outcomes.
- Model elements analysis.
- Automated workflow and technology setup.
- Solution use cases.
 - Straight viaduct.
 - Curved alignment: viaduct from Civil 3D input.
 - Curved alignment: viaduct from MX input.

Introduction

This document is the handout that provides context and more in-depth information for the presentation.

The topics covered in this document are the results of an engagement between Royal HaskoningDHV and Autodesk Consulting.

The purpose of the engagement was to explore the possibility of leveraging automation applied to Autodesk products to generate detailed models of viaducts suitable for representation, structural analysis and quantification.

The outcome was a workflow that could produce the Revit models for structural analysis drastically reducing the time required to model the same asset manually. Such models would also have a consistent organization and structure in terms of the elements, the modeling techniques and level of detail regardless the stakeholders involved in the design cycle.

Royal HaskoningDHV wanted to be able to manage the modeling of up to 50 viaducts with the same resources currently used to create one.

The result of the engagement is an information model based workflow that enables the creation of detailed viaduct models in Revit starting from an Excel spreadsheet input in less than 20 minutes. The models have the analytical features that enable the structural analysis in SOFiSTiK.

The automation was developed using Dynamo for Revit, a visual programming environment that allows to create logic routines. The project team attended several workshops with Autodesk:

- To establish a common language using the technology system and what best practices to adopt.
- To gather the functional and non-functional requirements for the automation.
- To develop the automation prototype and refine it to reach the desired performance.

In using the framework of people, process, and technology, it is acknowledged that no matter how good technology is and the processes that it may automate, without people engaged with the technology, understanding the daily data requirements and adopting the process, the technology will not function.

That is why Royal HaskoningDHV invested in an innovative process, with the support of Autodesk Consulting to deepen people knowledge on the technology and improve product adoption.

Inspiration

Royal HaskoningDHV was inspired by the class "Revitalize Viaduct Design" given by Matthias Stark at [AU 2015](#) that showed how to generate a viaduct in Revit using Dynamo starting from a Civil 3D input.

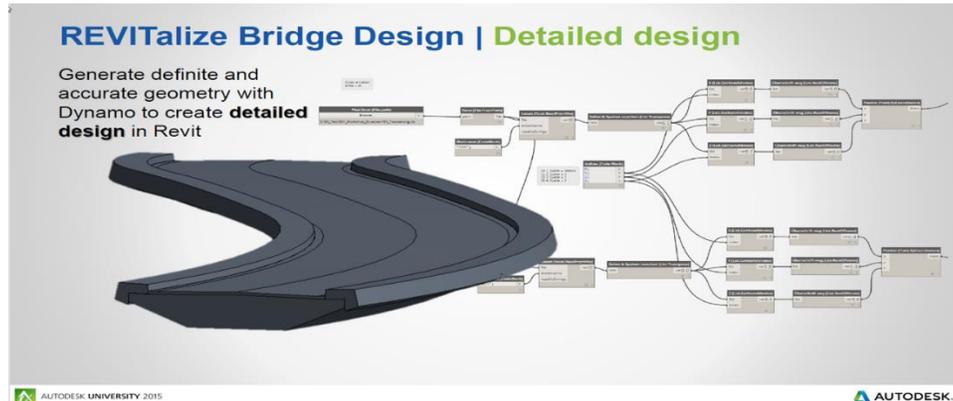


Figure 1: Excerpt of the AU 2015 class that inspired the engagement

Royal HaskoningDHV requested Autodesk Consulting to help with the automation of viaducts modelling. Many viaducts designs share specific design rules. The intent was to capture these rules into scripts that can be applied on viaduct designs. The differences between viaduct designs are well defined variables. The goal is to have the engineers to set the variables in a spreadsheet and let the script create the model and documentation. This will lead to the following benefits:

- Maintain an advantage on the market.
- Set the project team on the right path towards self-sufficiency.
- Reduce the working hours.
- Reduce the resources required.
- Reduce the errors in metadata.
- Improve collaboration.
- Enhance coordination among stakeholders.
- Enable new workflows and processes to solve design and structural analysis issues.

Technology

The investigation started with Revit 2016 and Dynamo 1.2, currently the solution is based on Revit 2018.1 and Dynamo 1.3 to leverage the ease of use of Dynamo Player and the input interface and to facilitate the deployment across projects.

Viaducts

This section of the handout describes the viaduct type for the automation.

Royal HaskoningDHV headquarters are in the Netherlands, in this Country the request for roadway viaducts are very consistent for a structural type of viaduct that covers approximately the 80% of the cases. The elements involved are very well defined in terms of shape and parameters, so that this kind of viaduct was an ideal candidate to explore the feasibility of an automated workflow. Following the outcomes of the initial analysis:

- Definition and optimization of the creation methods for objects that share the same shape characteristics (easier to implement and maintain).
- Distinction among objects with the same shape characteristics but different analytical behavior (i.e. foundation slabs and viaduct decks).
- Introduction of parameters for each element type for which the structural design input is needed (i.e. the number of girders per span, the definition of girders setbacks, etc.).

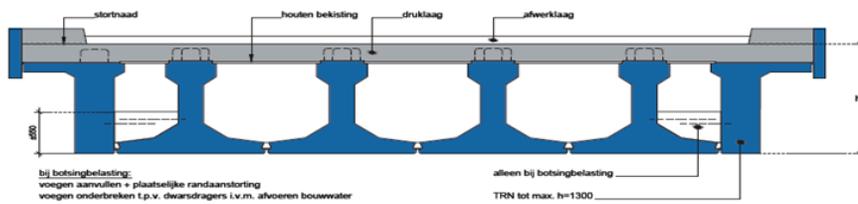


Figure 2: Typical section of a precast girder viaduct



Figure 3: Construction of a precast girder viaduct

General

All elements are placed on the level with elevation 0m from the sea level. This node group returns the level in the Revit model with elevation 0m.



Figure 4: Dynamo snippet to select a level at a given elevation

Deck

The decks are made of precast post-tensioned slabs with a unique slope across the span. The automation finds the best plane that minimizes the weight on the structure for each span. The decks were modeled as floors with a slope arrow. Each span has its own deck type defined in the Excel spreadsheet.

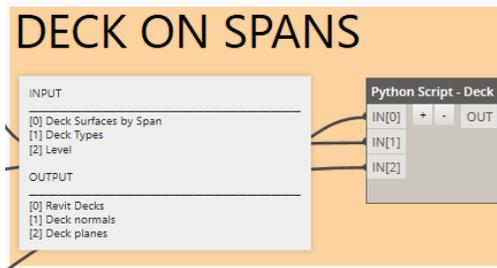


Figure 5: Python Script documentation in a Dynamo graph

Family Category	Floor
Structural	Yes
Analytical	Yes
Slope	..%

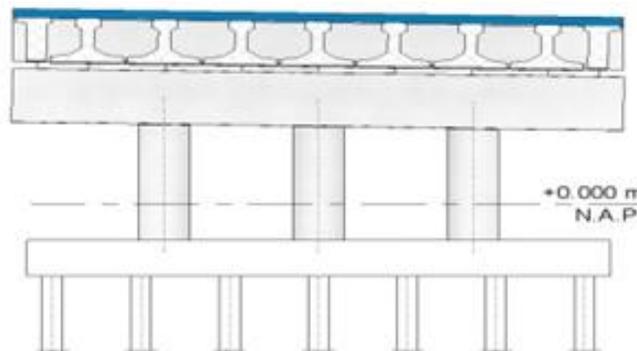


Figure 6: Deck cross section

Girders

These elements are precast beams. The girders along the longitudinal edges of the span are different than the inner girders. The edge girders have an asymmetrical cross section whilst the inner girders have a symmetrical one. The automation calculates the girders direction, the number of girders per span, their cross-section rotation to match the deck slope.

Family Category	Structural Framing
Analytical	Yes
Start Level Offset	x
End Level Offset	x
Cross-Section rotation	<i>Cross Fall</i>
Start Extension	x
End Extension	x
z Justification	Top
AngleLeft	x
AngleRight	x
Disallow Join	Yes

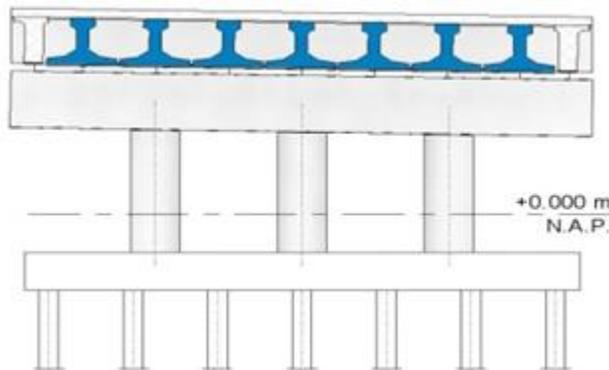


Figure 7: Inner Girders

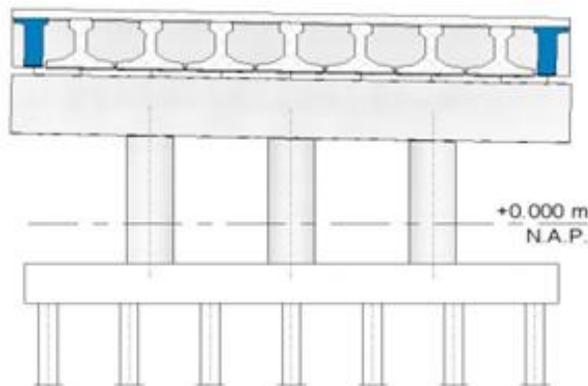


Figure 8: Edge Girders

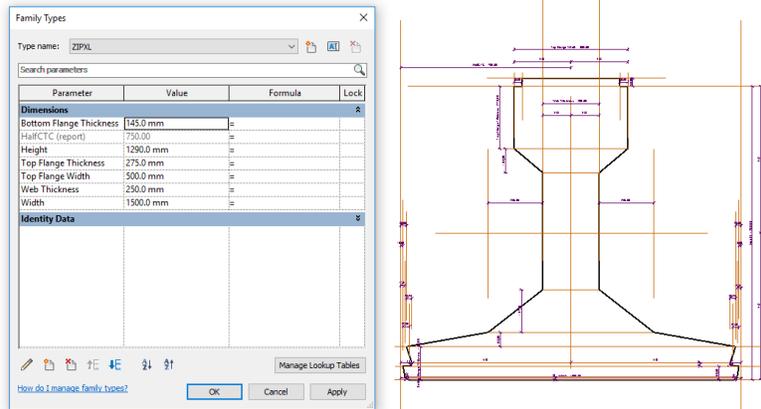


Figure 9: Detail of the Inner Girder parameters

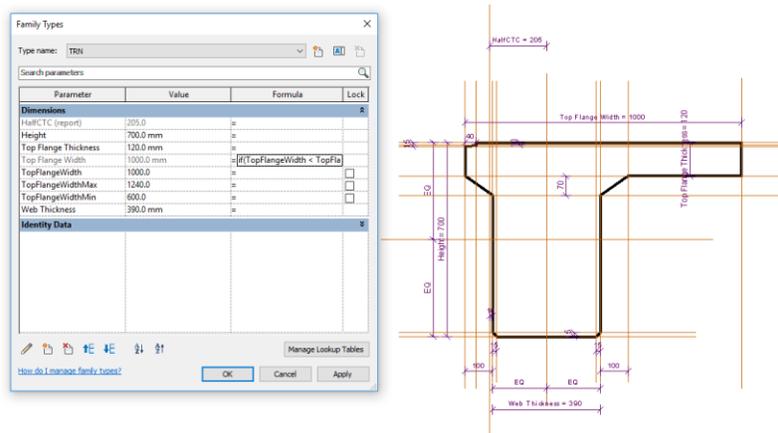


Figure 10: Detail of the Edge Girder parameters

The Cantilever of the edge girder is variable, to determine the width of the edge girder we needed a calculated parameter in the family, calculated and set by Dynamo.

Top Flange Width =

if(TopFlangeWidth < TopFlangeWidthMin, TopFlangeWidthMin, if(TopFlangeWidth > TopFlangeWidthMax, TopFlangeWidthMax, TopFlangeWidth))

```
restSpaceSizeGirders = (bridgeWidth - (2 * topFlangeWidthMin) - (innerGirdersNumber * topFlangeWidth));
edgeGirderWidth = (topFlangeWidthMin + (restSpaceSizeGirders / 2));
```

Figure 11: Excerpt of a Code Block formula used to calculate girders layout

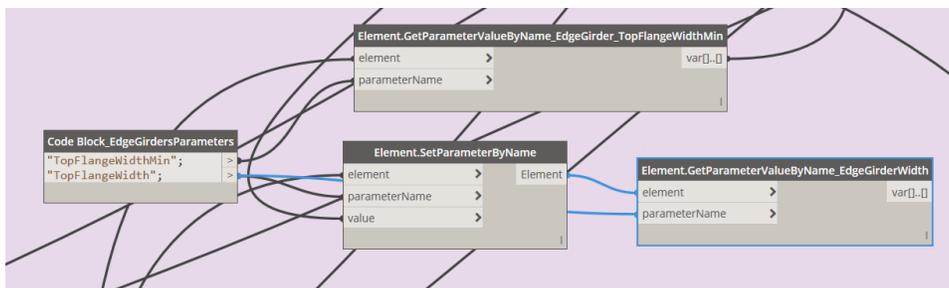


Figure 12: Excerpt of Dynamo graph to get and set edge girders parameter values

End Cap Walls

These elements have the function to prevent the girders from moving when they are in place but, structurally, they are not taken into consideration. The logic behind their creation is contained in a Python Script. It starts from the support lines definition and follows the slope of the deck. It creates fixed thickness basic walls which profiles have been edited. These walls are set to be *non-bearing* (with no analytical model attached). This structural detail is important for the quantification and construction phase.

The Girders and End Cap Wall are joined together (Girder wins over Wall).

Family Category	Wall
Wall Profile	
Structural	Yes
Analytical	No

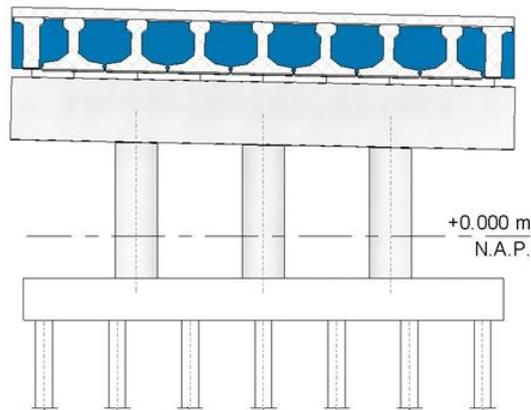


Figure 13: Typical Cap Wall in a cross section

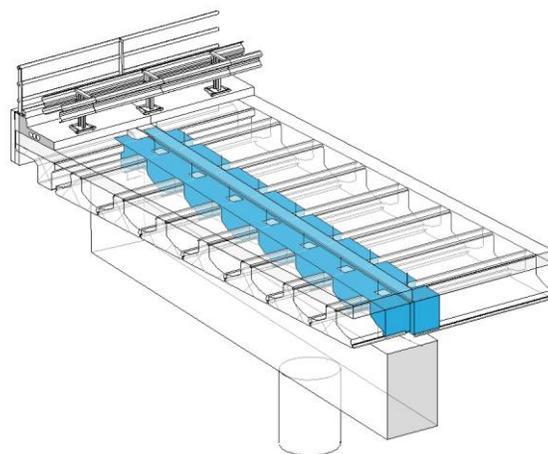


Figure 14: Detail of cap walls on expansion joint

Abutments

The top face of the front wall of the abutment follows the superelevation of the deck and since it is not possible to specify a top reference via Revit API that is not horizontal, a Python Script was used to edit the profile of the front wall.

The shape characteristics of the front wall and the wing walls are defined in Dynamo creating loft surfaces.

Family Category	Structural Foundation,
Structural	Yes
Analytical	Yes
Family Category	Wall
Wall Profile	

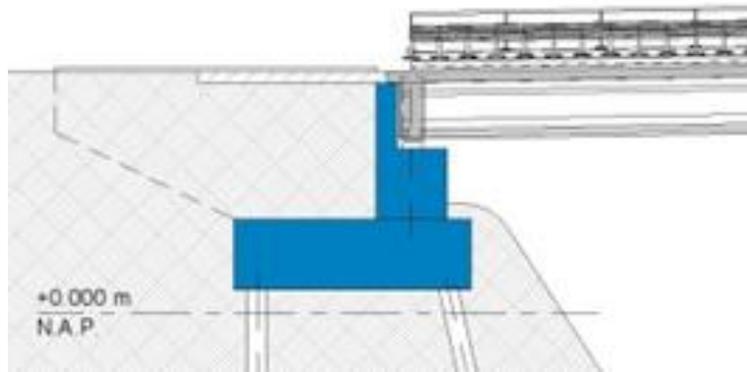


Figure 15: Low Abutment longitudinal section

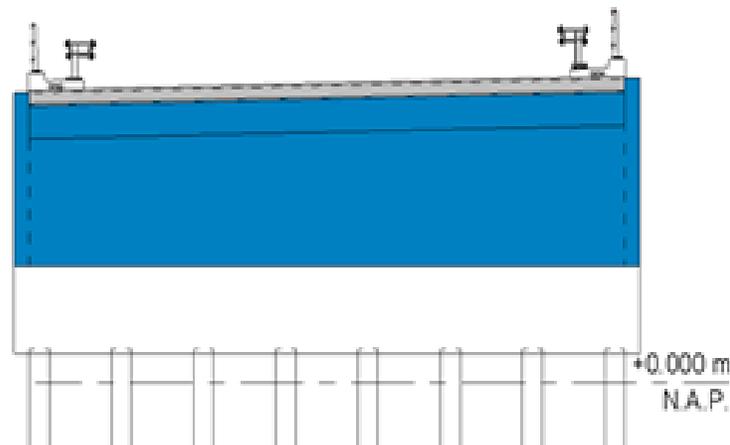


Figure 16: Abutment in cross section, the top face follows the deck superelevation

Support beams

The intermediate supports are cast-in-situ concrete beams. Their location is determined by the length of each span measured from the center point. The rotation is a parameter provided in the main Excel spreadsheet for each support measured with respect to the World Coordinate System X Axis. The support beam follows the superelevation of the deck so that the top face is parallel to the bottom face of the girders with a fix offset that depends on girders height and deck thickness. The length of the support beam is derived from the span width, the orientation angle and the superelevation.

Family Category	Structural Framing
Analytical	Yes
Start Level Offset	
End Level Offset	
Cross-Section rotation	0
z Justification	Top

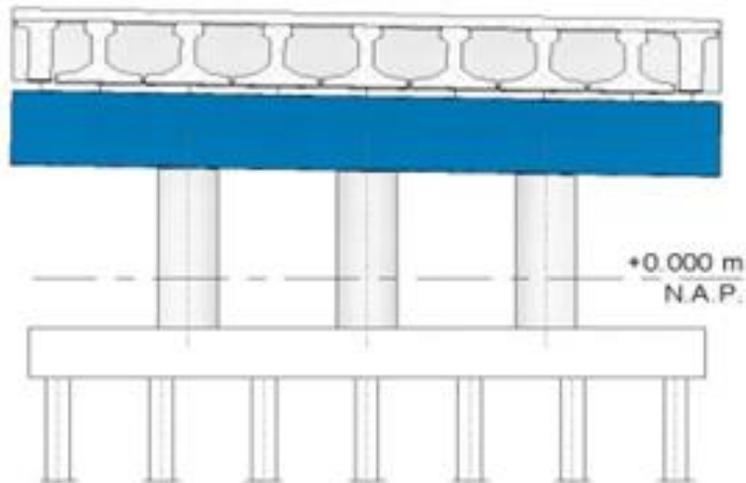


Figure 17: Support beam in relation to the girders

Columns

The support beams can have a different amount of support columns under it; this is an input from the Excel spreadsheet from the structural engineer. The Excel spreadsheet also sets the family type for the structural circular column to be used. The columns are evenly distributed in a layout that follows the support beam. The geometry specifications of the columns are defined in the Excel spreadsheet (number, size and height). The resulting analytical model is connected to the support beam analytical model.

Family Category	Structural Columns
Analytical	Yes

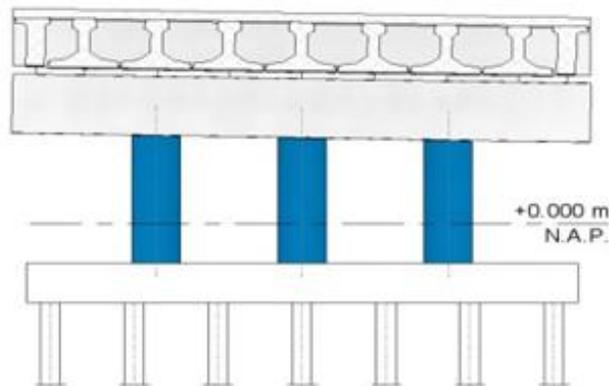


Figure 18: Circular support columns

Foundation slabs

These elements are located underneath the structural columns at a specified elevation and have a shape that depends on the orientation of the support and the amount and dimensions of the columns. The resulting elements are flat foundation slabs and correspondent analytical model.

Family Category	Structural Foundation Slab
Structural	Yes
Analytical	Yes

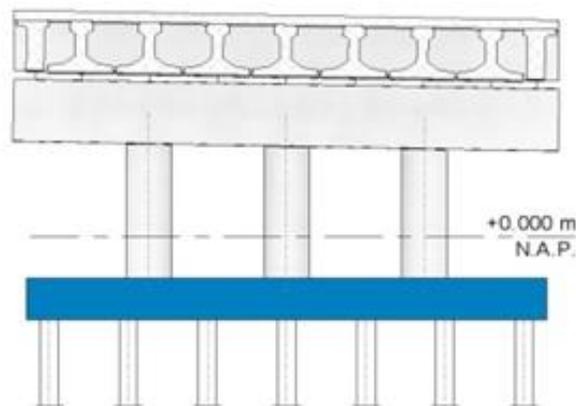


Figure 19: Foundation slab cross section

Foundation piles

These elements are placed under the foundation slabs of the supports and they are typically structural foundation families with a nested annotation for the symbolic representation in foundation layout drawings. For analytical purposes, it was decided to use structural columns instead because structural foundation objects in Revit do not support a stick analytical model.

Family Category	Structural Columns
Column Style	Slanted – End Point Driven
Analytical	Yes

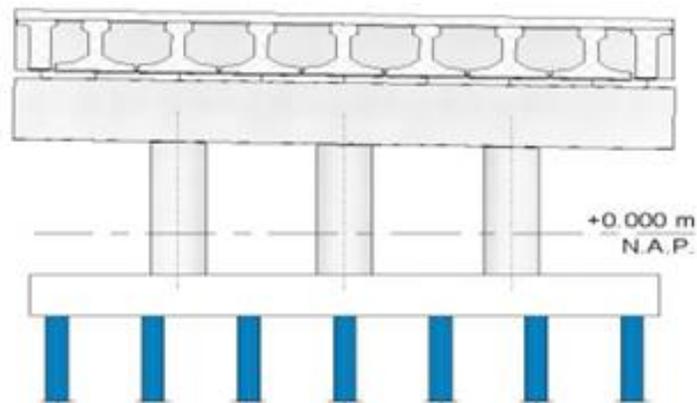


Figure 20: Foundation piles under a foundation slab

Analytical Rigid Links

These elements transfer the loads from the girders to the supports in the analytical model (abutments or support beams). They are family instances that follow the same orientation of the girders, their analytical model is obtained as a group of three beams with no weight and a very small cross section associated:

- From the end of the girders to the top of the bearing with infinite stiffness
- From the top of the bearing to the bottom of the bearing with known stiffness (spring behavior).
- From the bottom of the bearing to the analytical model of the support with infinite stiffness.

This was necessary since it is not possible to introduce intermediate node in the analytical model of the supports and creating analytical links via Revit API would have produced an incorrect model for the structural analysis. The automation produces a detailed Excel spreadsheet containing the information to assign the structural behavior to the SOFiSTiK elements.

Family Category	Structural Framing
Type	Infinite Stiffness or Spring
Analytical	Yes
Start Level Offset	...
End Level Offset	...
Cross-Section rotation	...
z Justification	Top

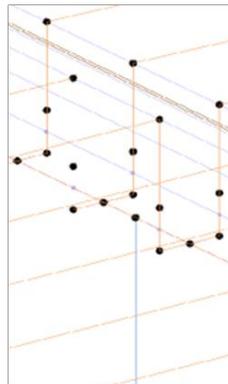


Figure 21: Detail of the analytical links at the ends of the girders

Bearings

These are the elements that physically transfer the loads from the girders to the support beams or abutments. In this context, they have no analytical behavior.

Family Category	Generic Model Adaptive
-----------------	------------------------

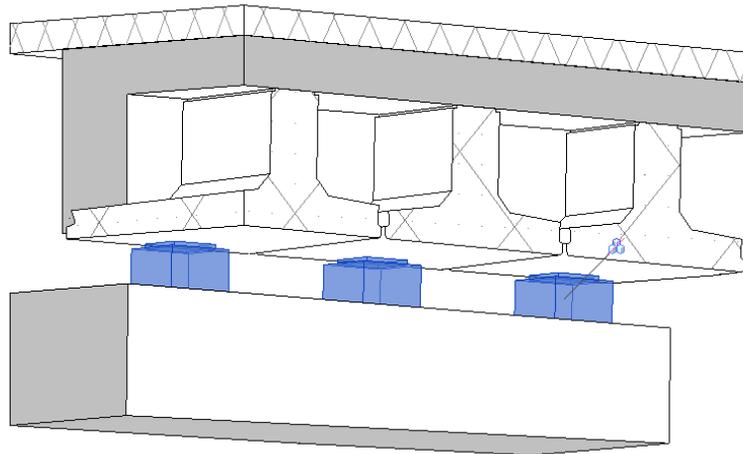


Figure 22: Detail bearings (basic type)

Transition plates

The transition from the viaduct to the ground happens on precast plate elements. These are detailing elements with no analytical behavior.

Family Category	Generic Model Adaptive
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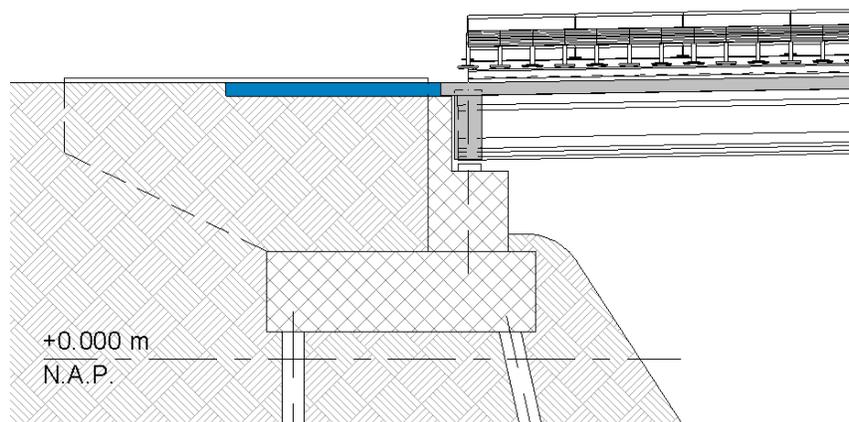


Figure 23: Transition plates on a longitudinal section

Shoulders

These longitudinal elements follow the longitudinal edges of the viaduct and provide the delimitation for the road and walkways. They also host the barriers on the top face and the electrical system distribution. The cross section of the shoulders is standard and can be described with six points, the final adaptive components used has twelve points to define back and front faces.

Family Category	Generic Model Adaptive
Adaptive	12 Points

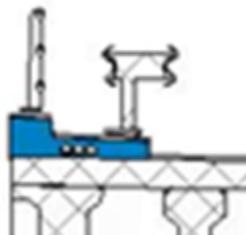


Figure 24: Detail of a Cast-In-Situ shoulder

Edge panels

These objects are hosted on the bottom face of the shoulders and are represented by two-points adaptive components.

Family Category	Generic Model Adaptive
Adaptive	2 Points

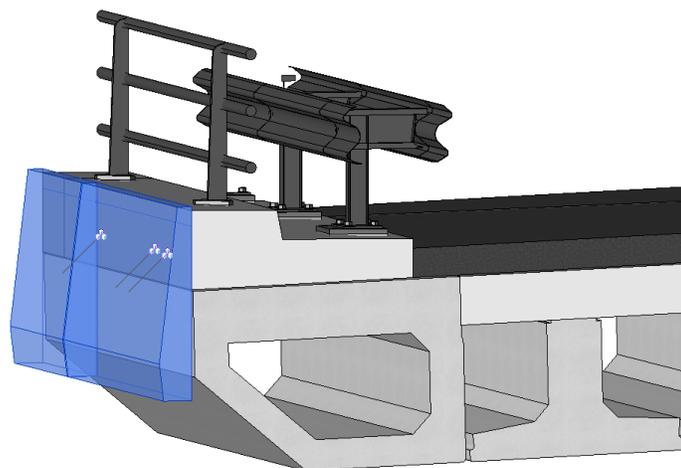


Figure 25: Detail of the edge panels

Barriers

These objects are hosted on the top face of the shoulders and are represented by two-points adaptive components.

Family Category	Generic Model Adaptive
Adaptive	2 Points



Figure 26: Typical barrier elements along the viaduct

Railings

These objects are very similar to barriers and conceptually there are no differences.

Family Category	Generic Model Adaptive
Adaptive	2 Points

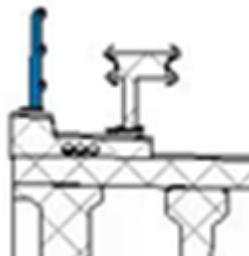


Figure 27: Railings on the viaduct edges

Other disciplines elements

The goal of the automation was limited to the structural discipline, with the exception of some non-structural elements. The integration with other discipline elements was not part of the original engagement and will not be covered in this document. Nevertheless, these objects could be part of the automation applying the same approach and principles used to define the structural elements and gather their specific requirements to expand the current workflow.

Workflow overview

The proposed solution is as follows:

- The structural designer compiles a pre-set Excel spreadsheet with the data that defines the viaduct:
 - The overall definitions of the viaduct (length, width, **number of spans, span lengths**, deck thickness, girder types, etc.).
 - The definitions of the abutments.
 - The definition of the intermediate supports.
- The designer input is processed in the background in **Excel and defines key parameter** values for the automation in Dynamo.
- The Revit modeler opens a new project starting from a template with the optimized settings and that contains the families and types of objects controlled from the Excel spreadsheet.
- The Revit modeler opens a Dynamo session and loads the Automated Viaduct Design solution and select the Excel spreadsheet defined by the structural designer.
- The Dynamo graph processes the input and creates a complete viaduct model ready to be passed to the Structural Analysis team and start the Drawing Production.

The automation and the data input via Excel reduce the efforts to interpret the design data and improve the overall quality of the process via a robust communication framework.

The design intent is captured clearly and it is ready to be used by the modelers. This approach has reduced the overall time to create the models drastically and assured that the final results meet the same quality standards.

More design options have been introduced thanks to the implementation of a new piece of technology by Autodesk Consulting that enables to store the results of a Dynamo session into a JSON file (Java Script Object Notation). This enabled a more efficient exchange of information that is based on geometry output to drive automation in other areas (i.e. applying the loads to the analytical model, modify the logic of the girders layout for a particular span of the viaduct, etc.).

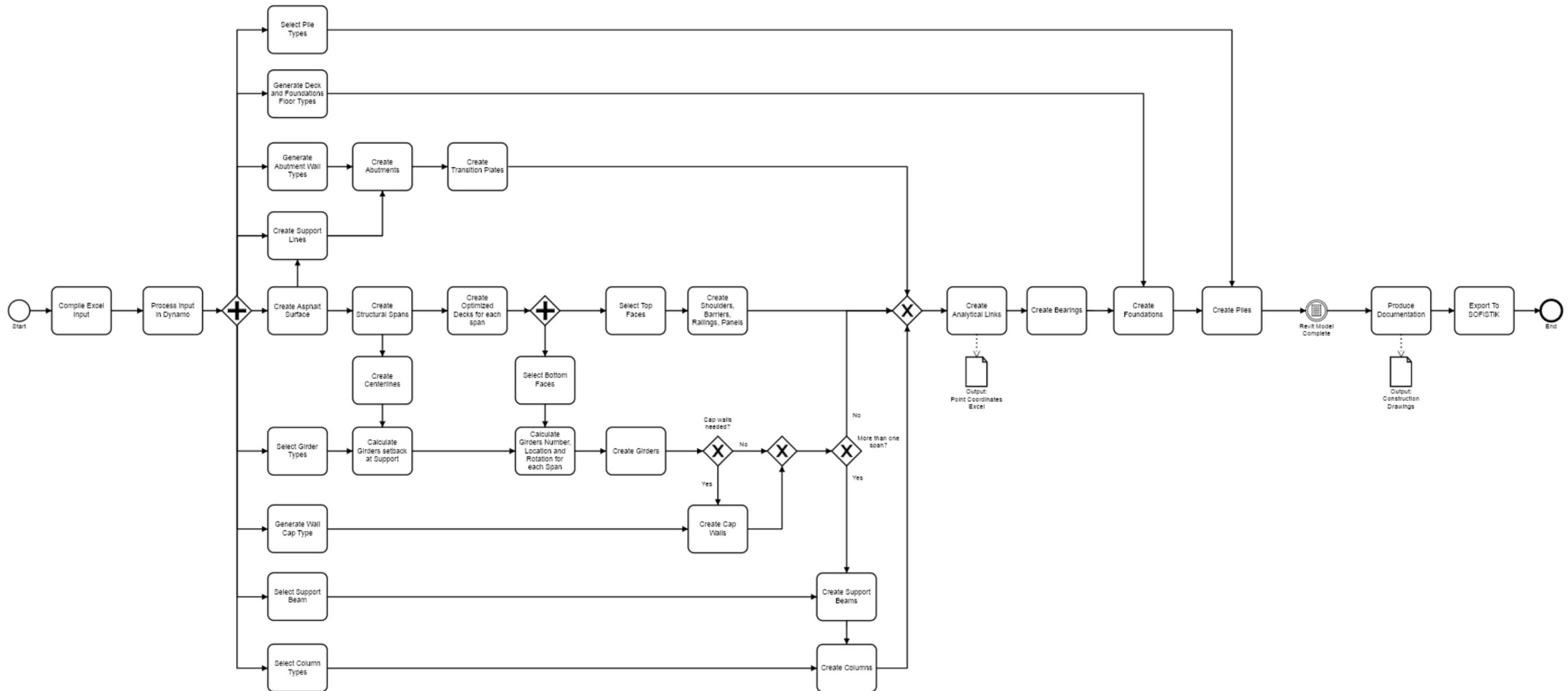


Figure 28: Process diagram for the automated viaduct solution.

BIM Uses

Following a list of BIM Uses enabled by this workflow and the benefits that an automated approach can bring in terms of consistency and control over the design process.

Model Authoring

The automated workflow allows to create models for the viaducts with a consistent level of development and detail. These models are used to enable the other BIM Uses, the automation makes this process scalable and repeatable.

Drawing Production

The information models are used to create drawings and drawing sets. This including Schematic, Design Development, Construction and Shop Drawing. The same model can be used to create all drawing, reports, and analysis datasets. This eliminates the need to manually update each drawing for each design change. Standard construction details can be generated directly from the model, and they are the basis for the definition of the rules to implement in the automated generation of the model.

Structural Analysis

The information model is used to determine the most effective combination of structural elements based on design specifications. Development of this information is the basis for what will be passed on to the owner and/or operator for use in the viaduct. These analysis tools and performance simulations can significantly improve the design of the viaduct and its lifecycle from the conception to the construction. The automated exchange of information among authoring and analysis platforms reduces the risks of non-coordinated design data.

Quantity Take Off

The information models can be used to assist in the generation of accurate quantity take-offs and cost estimates throughout the lifecycle of a project. This process allows the project team to see the cost effects of their changes, during all phases of the project, which can help curb excessive budget overruns due to project modifications.

2. Add/check parameters
 - Viaduct Width
 - Number of Spans

Automatic Bridge Template				
Discription	Information	Units		
General				
Bridge Length	32000	mm		
Bridge Width	25000	mm		
Number of Spans	2	(max.=10)		
Deck				
	Length	DeckThickness	Inner Girder	Edge Girder
Spans	[mm]	[mm]	Type	Type
Span_1	16000	230	ZIP500	TRN500
Span_2	16000	230	ZIP500	TRN500

Figure 31: Excel input, overall design data for the viaduct

- Fill in Span lengths
- Deck thicknesses
- Inner Girder types
- Edge Girder types

Deck	Length	DeckThickness	Inner Girder	Edge Girder
Spans	[mm]	[mm]	Type	Type
Span_1	16000	230	ZIP500	TRN500
Span_2	16000	230	ZIP500	TRN500

Figure 32: Excel input, spans design data

- Deck top elevation at supports
- Foundation bottom elevations
- Support rotation angles
- Number of columns at intermediate support (end supports are always abutment walls)
- Foundation piles bottom elevation

Supports	Top_Level_Deck	Bottom_Level_SFO	Crossing Angle	Nr. of columns	PilePit_Level
	[mm] regarding N.A.P.	[mm] regarding N.A.P.	[degrees]	[nr.] (max.=5)	[mm] regarding N.A.P.
Abutment_1	4500	-1250	90		-15000
Support_1	4550	-2500	90	3	-16000
Abutment_2	4600	-2500	90		-16000

Figure 33: Excel input, supports design data

- Assign superelevation (cross fall)
- Cap walls width
- Bearings clearance minimum height

Deck general	Value	Units
Crossfall	-2,5	%
CapWall_Width	500	
Joint Width	20	mm
Bearing_Clearance_Height	200	mm

Figure 34: Excel input, deck cross design data

- Abutment Types (high or low)
- Abutment dimensions
- Wingwall dimensions

Abutments	
Abutment Type 1 (West / South)	Low
Abutment Type 2 (East / North)	High

Figure 35: Excel input, abutment type selection

Measurements Abutment Type Low		
Front Wall		
Length		mm
Width	800	mm
Foundation Slab		
Bottom_Level_Slab (regarding N.A.P.)	-1250	mm
Width	4500	mm
Toe	0	
Thickness	1500	mm
Wingwall		
Wingwall Length	5000	mm
Wingwall Width	300	mm

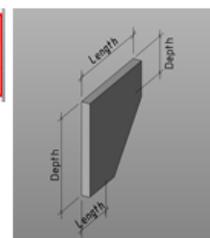
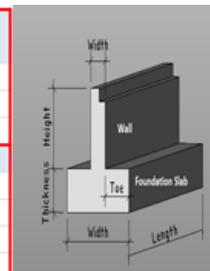


Figure 36: Excel input, abutments design data

- Foundation dimensions
3. Save Excel spreadsheet with name

Revit

4. Start Revit template

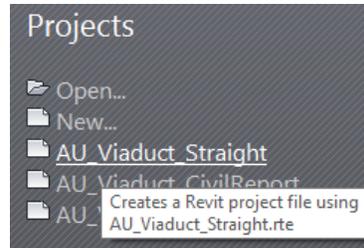


Figure 37: Load Revit template for viaducts

Dynamo

5. Launch Dynamo Player
6. Start the Dynamo graph

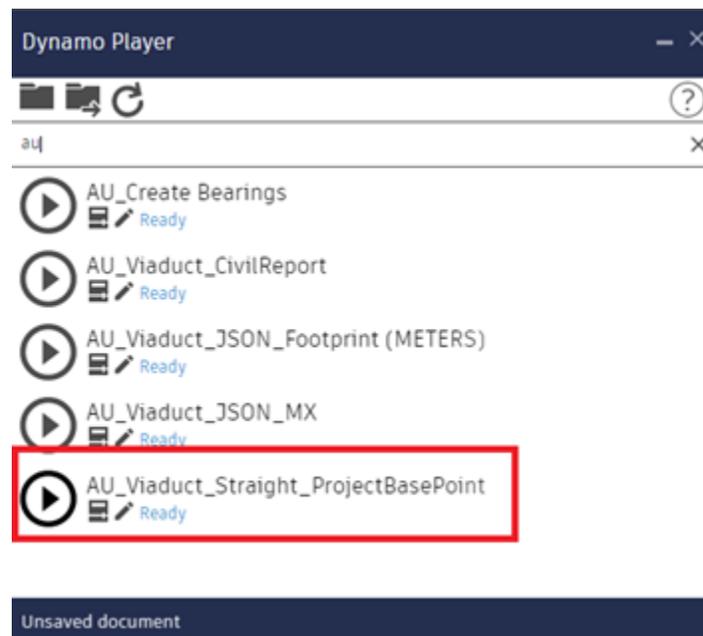


Figure 38: Dynamo player interface

7. Browse to Excel File



Figure 39: Dynamo Player input interface in Revit 2018.1

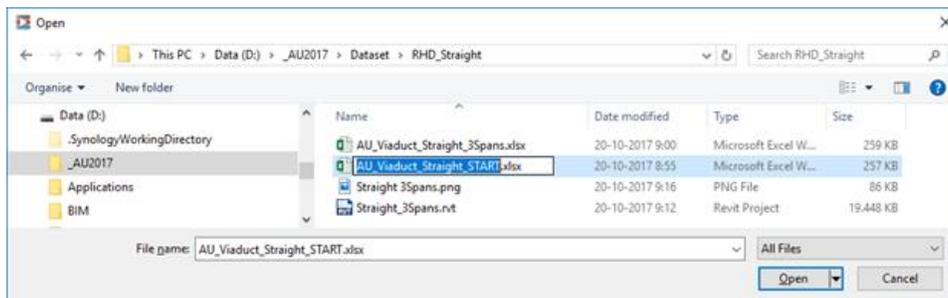


Figure 40: Browse to the Excel input file for the project

8. Run the graph and wait for completion



Figure 41: Running a Dynamo graph via Dynamo player

9. Model completed

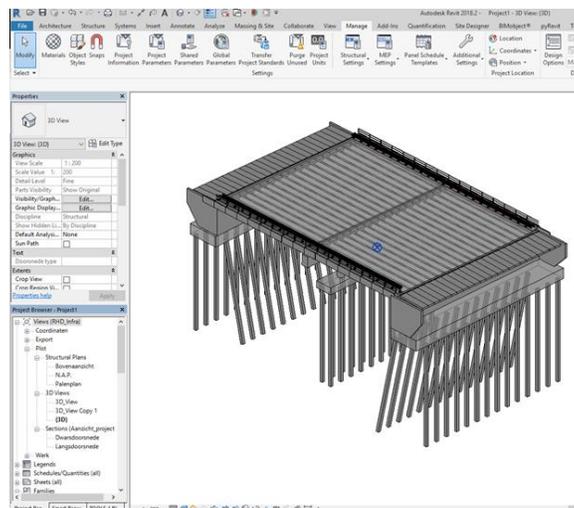


Figure 42: Revit model of the viaduct produced by the Dynamo graph

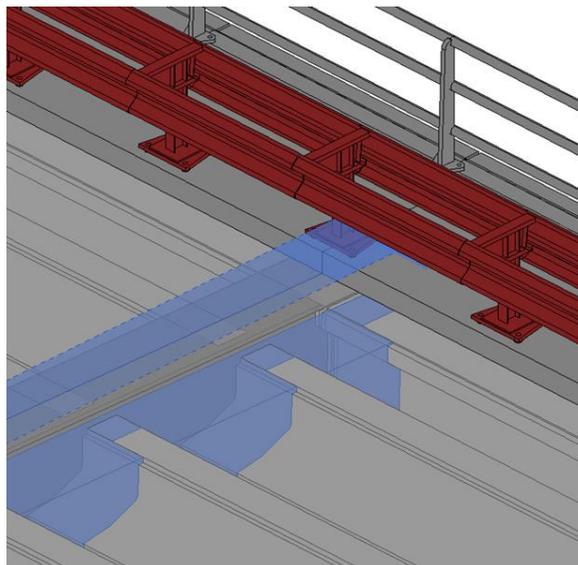


Figure 43: Detail of the resulting Revit model

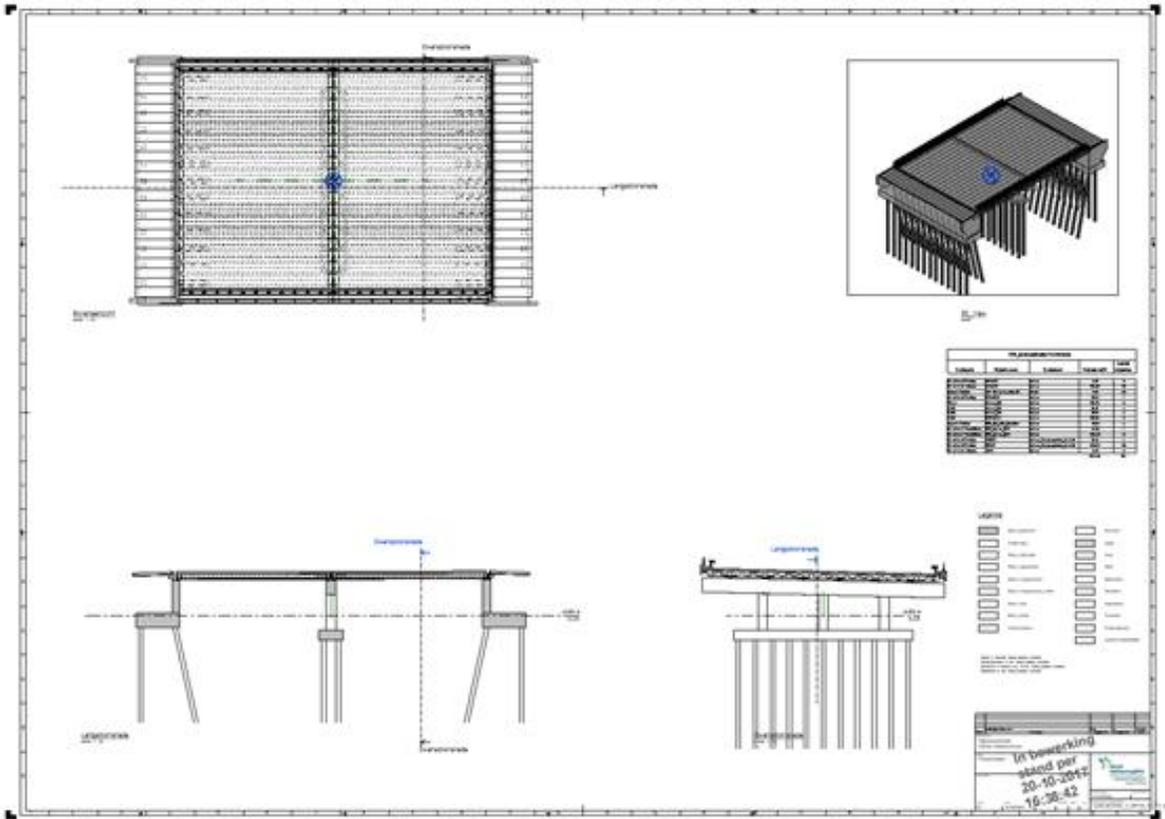


Figure 44: Preset drawing sheet

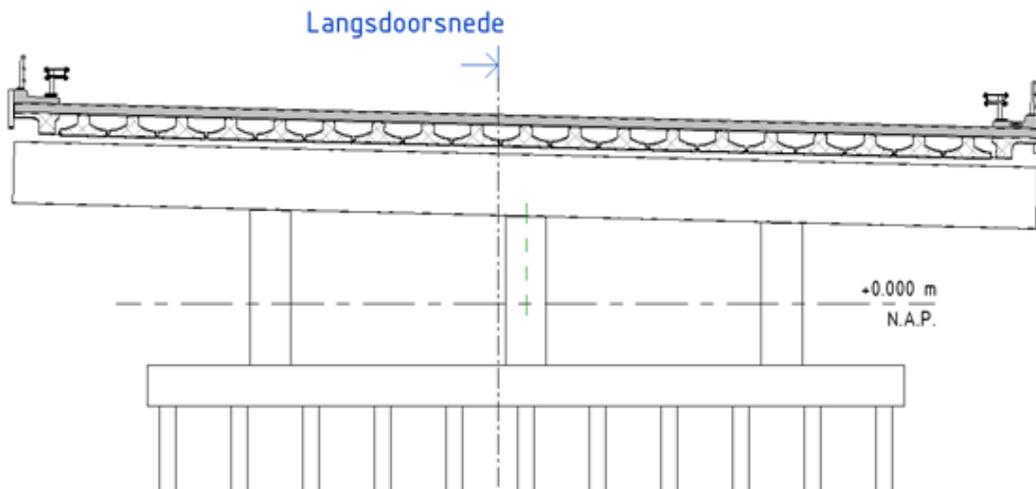


Figure 45: Cross Section detail

RHD_Hoeveelheden Materialen				
Category	Objectnaam	Materiaal	Volume (m3)	Aantal objecten
Structural Framing	300x400	Beton	5.89	2
Structural Columns	400x400	Beton	176.67	78
Generic Models	600 (Beton verankerd)	Staal	0.69	48
Structural Framing	1000x1500	Beton	37.51	1
Floors	Beton_230	Beton	184.06	2
Walls	Beton_300	Beton	25.10	4
Walls	Beton_500	Beton	12.98	4
Walls	DYN-800.0	Beton	137.35	2
Generic Models	RHD_GM_AC12_Shoulder	Beton	13.45	4
Structural Foundations	SFO_Beton_1000	Beton	46.25	1
Structural Foundations	SFO_Beton_1500	Beton	345.60	2
Structural Framing	TRN500	Beton_Voorgespannen_Prefab	18.48	4
Structural Framing	ZIP500	Beton_Voorgespannen_Prefab	193.47	38
Structural Columns	#1000	Beton	8.52	3
			1206.23	193

Figure 46: Quantity Take-Off

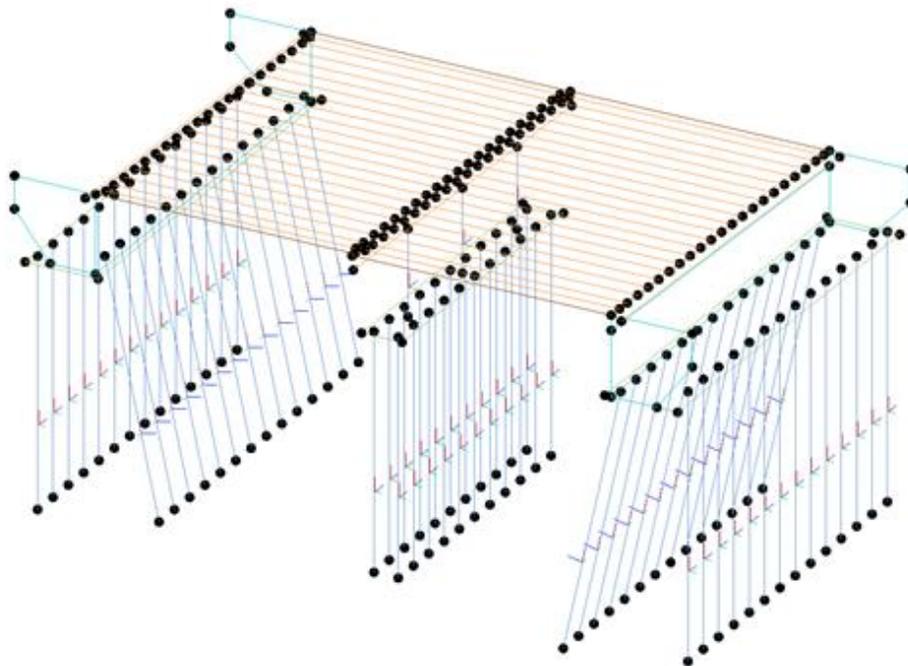


Figure 47: Analytical model of the viaduct

SOFiStiK

10. Export to SOFiStiK

- Map Materials
- Map section
- Export
- SSD Main System in SOFiStiK

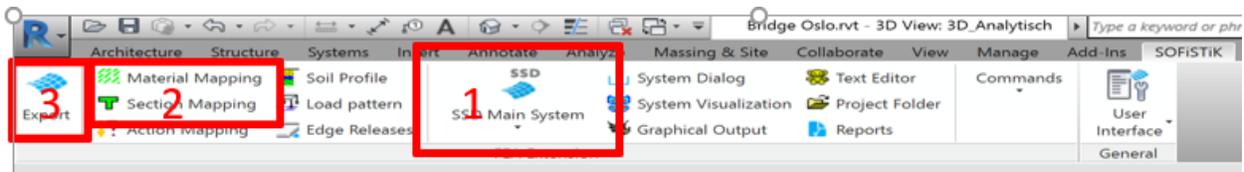


Figure 48: SOFiStiK Toolbar in Revit

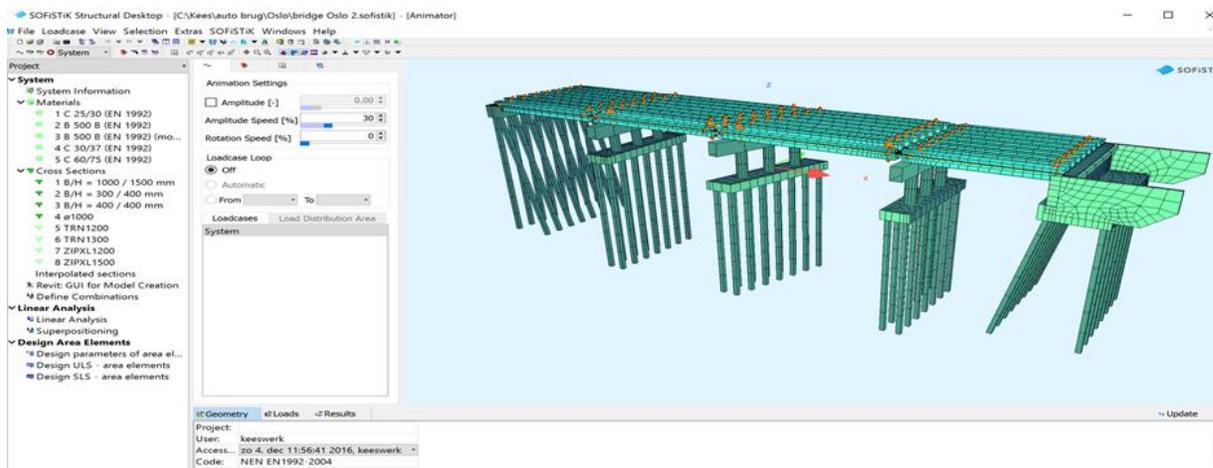


Figure 49: SOFiStiK structural model

Curved alignment: viaduct from a Civil 3D input

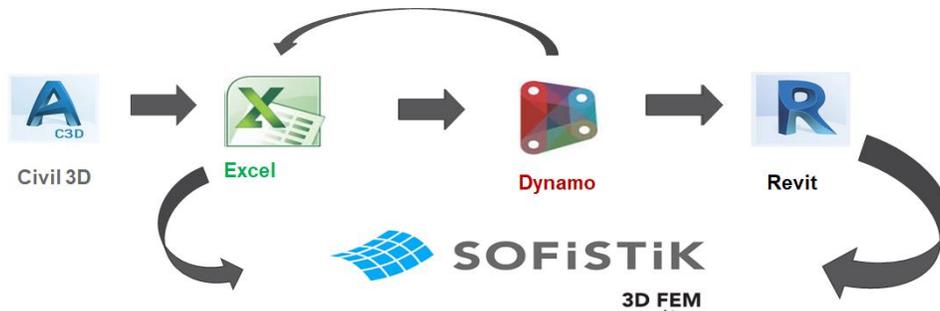


Figure 50: Workflow and tools for the curved viaduct from Civil 3D use case

This use case differs from the straight viaduct only in a few initial steps to setup the design data.

Civil 3D

1. Load the Civil 3D corridor model
2. Extract the Corridor coordinates via Civil Report

Excel

3. Complete design data as per the straight viaduct
4. Add the station values for the supports
5. Save the spreadsheet with name

Revit

- Same as the previous case

Dynamo

- Same as the previous case

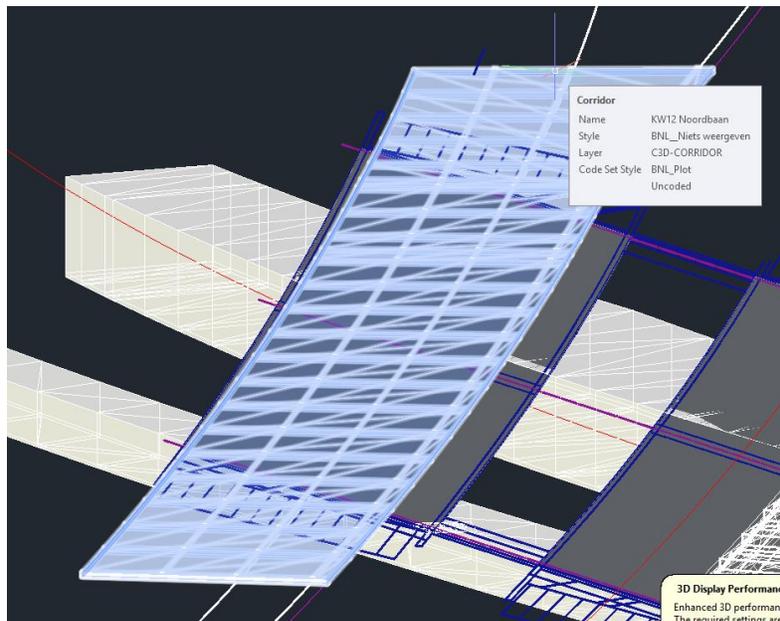


Figure 51: Corridor model of the carriageway in Civil 3D

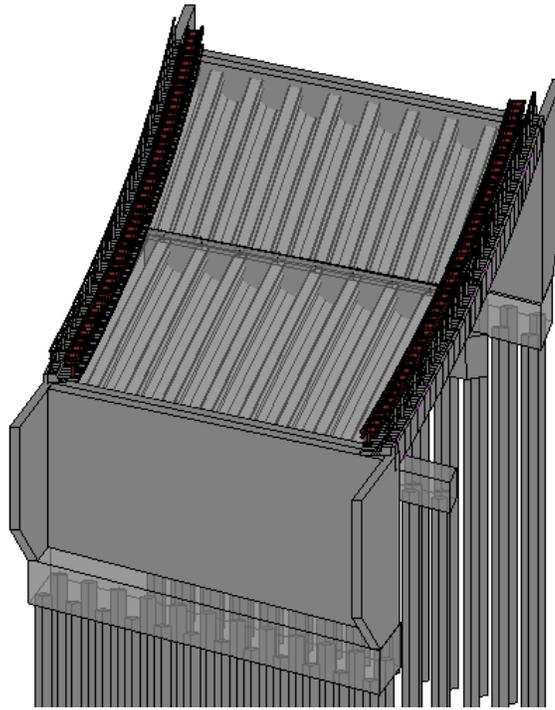


Figure 52: Revit model of the viaduct

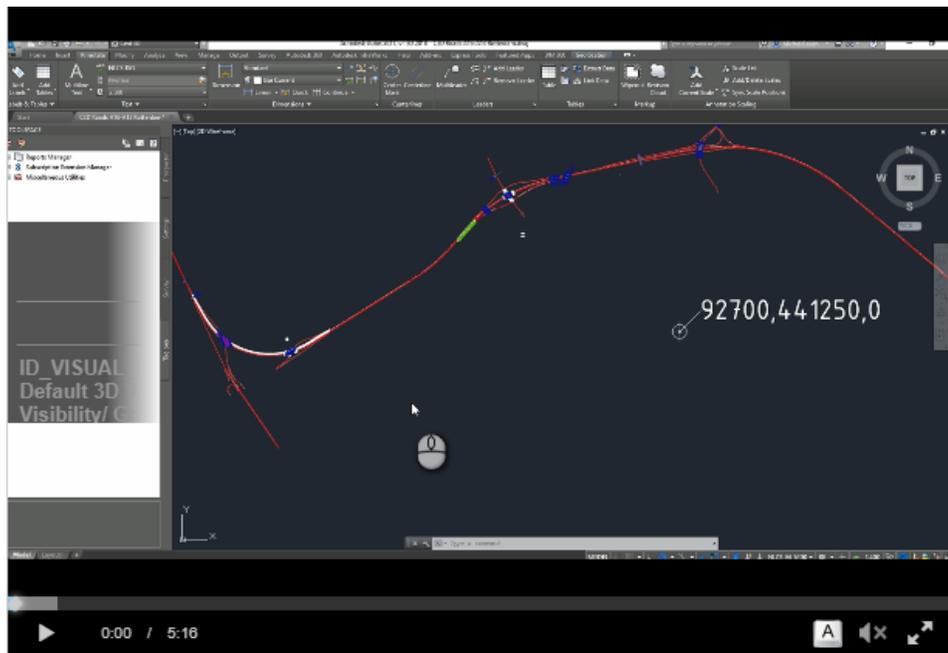


Figure 53: Screencast RHD_Viaduct_Civil Report <http://autode.sk/2y6bxaU>

Curved alignment: viaduct from MX

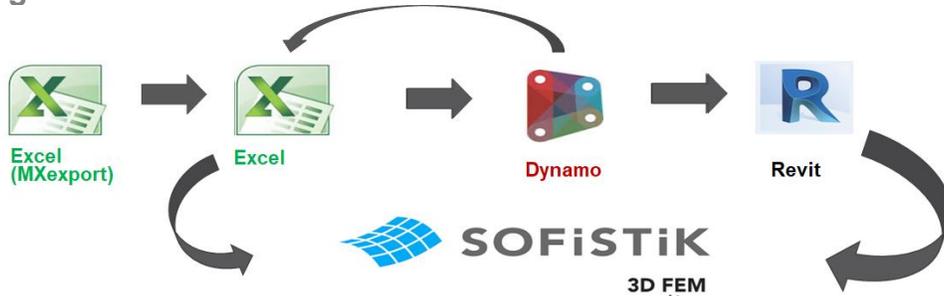
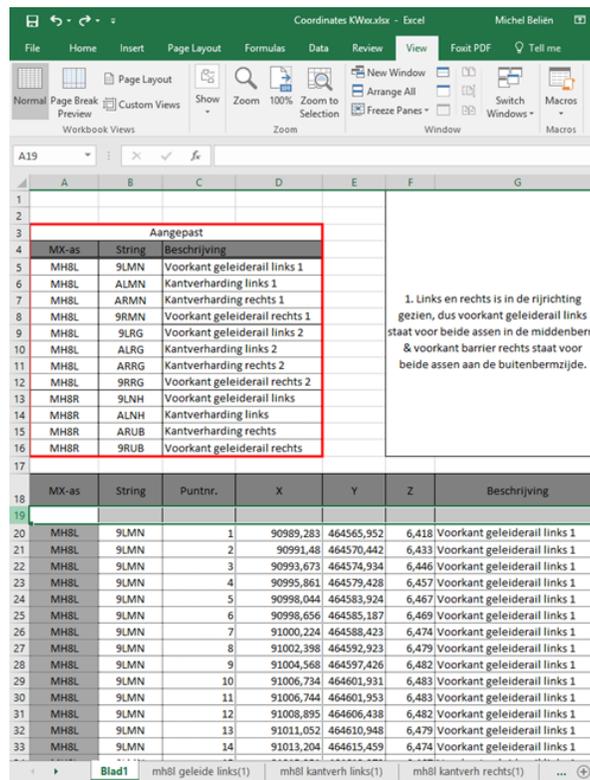


Figure 54: Workflow and tools for the curved viaduct from MX use case

This workflow differs from the previous case in the initial steps to acquire the design input. Revit and Dynamo setup are different: the user defines the viaduct footprint and the support locations in Revit and uses an intermediate JSON file to capture the output of two Dynamo sessions.

Excel MX Data

1. Open MX coordinates report
2. Check the information like axis, strings and descriptions
3. Check the number of rows to drop (i.e. headers that do not contain information)



MX-as	String	Beschrijving
MHBL	9LMN	Voorkant geleiderail links 1
MHBL	ALMN	Kantverharding links 1
MHBL	ARMN	Kantverharding rechts 1
MHBL	9RMN	Voorkant geleiderail rechts 1
MHBL	9LRG	Voorkant geleiderail links 2
MHBL	ALRG	Kantverharding links 2
MHBL	ARRG	Kantverharding rechts 2
MHBL	9RRG	Voorkant geleiderail rechts 2
MHBR	9LNH	Voorkant geleiderail links
MHBR	ALNH	Kantverharding links
MHBR	ARUB	Kantverharding rechts
MHBR	9RUB	Voorkant geleiderail rechts

MX-as	String	Puntnr.	X	Y	Z	Beschrijving
MHBL	9LMN	1	90989,283	464565,952	6,418	Voorkant geleiderail links 1
MHBL	9LMN	2	90991,48	464570,442	6,433	Voorkant geleiderail links 1
MHBL	9LMN	3	90993,673	464574,934	6,446	Voorkant geleiderail links 1
MHBL	9LMN	4	90995,861	464579,428	6,457	Voorkant geleiderail links 1
MHBL	9LMN	5	90998,044	464583,924	6,467	Voorkant geleiderail links 1
MHBL	9LMN	6	90998,656	464585,187	6,469	Voorkant geleiderail links 1
MHBL	9LMN	7	91000,224	464588,423	6,474	Voorkant geleiderail links 1
MHBL	9LMN	8	91002,398	464592,923	6,479	Voorkant geleiderail links 1
MHBL	9LMN	9	91004,568	464597,426	6,482	Voorkant geleiderail links 1
MHBL	9LMN	10	91006,734	464601,931	6,483	Voorkant geleiderail links 1
MHBL	9LMN	11	91006,744	464601,953	6,483	Voorkant geleiderail links 1
MHBL	9LMN	12	91008,895	464606,438	6,482	Voorkant geleiderail links 1
MHBL	9LMN	13	91011,052	464610,948	6,479	Voorkant geleiderail links 1
MHBL	9LMN	14	91013,204	464615,459	6,474	Voorkant geleiderail links 1

Figure 55: MX coordinates report spreadsheet

Revit Setup

1. Start Revit template
2. Attach DWG contours
3. Set Project Base Point coordinates as per BIM Execution Plan
4. Create model lines for the viaduct footprint
5. Create grids to define the viaduct supports

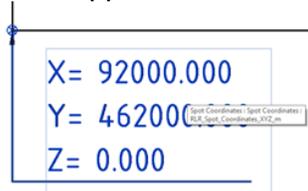


Figure 56: The project base point in the Revit model set as per BIM Execution Plan

Dynamo Setup

6. Launch Dynamo Player
7. Open Dynamo graph “AU_Viaduct_JSON_Footprint (Meters)” clicking on the pencil icon (Edit in Dynamo)



Figure 57: Dynamo Player can load the Dynamo User Interface of the graph for edits

8. Run the Python Script to set the current Revit length units to Meters (MX- Data is in Meters, the default Revit template is in millimeters)

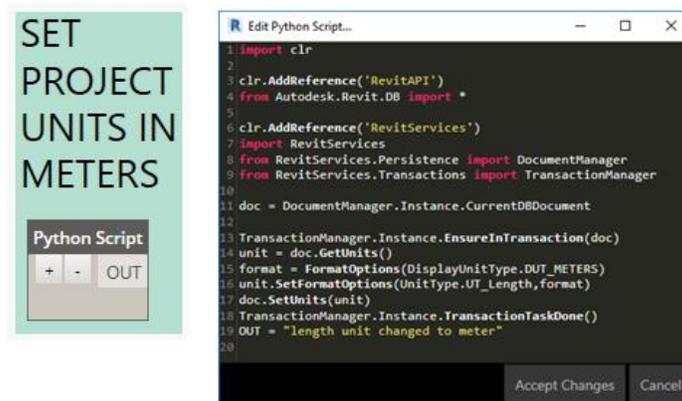


Figure 58: Python Script to change the Revit User Interface units for length dimensions

[“Authored by: Einar Raknes, Source DynamoBIM.org 2016”](#)

9. Select MX coordinates report
10. Set the number of rows to drop

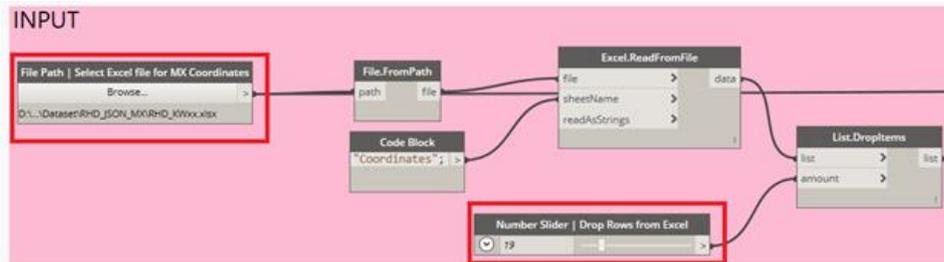


Figure 59: Set the values to process the coordinates report

11. Check the Excel input
12. Group by MX-axis

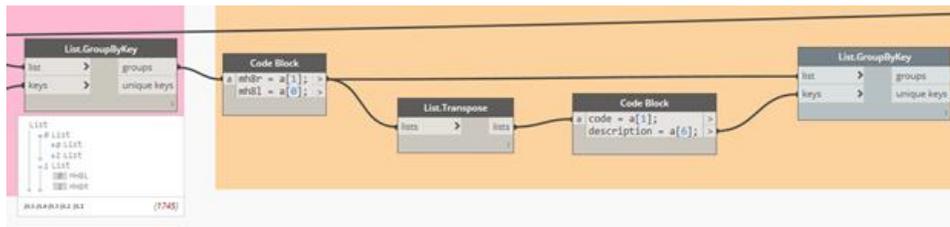


Figure 60: Group input values by description

13. Split the values by side (1= Left ETW, 2 = Right ETW)

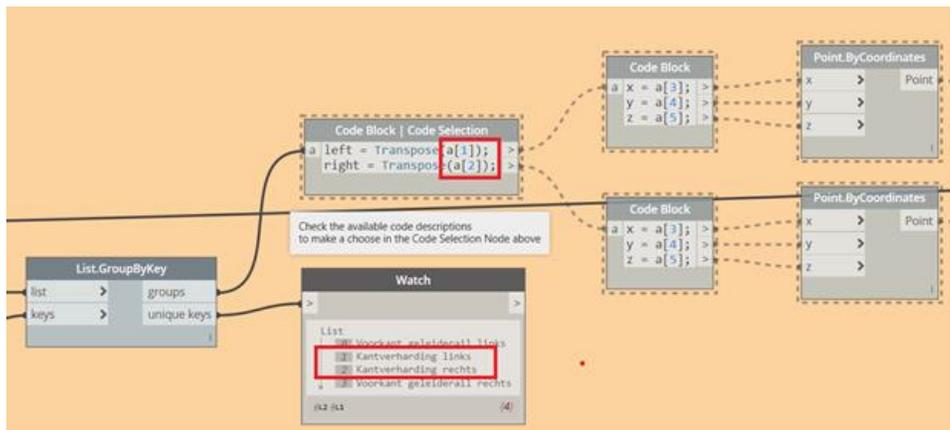


Figure 61: Split the input values using a Code Blocks and Design Script syntax

14. Unfreeze Code Block | Code Selection

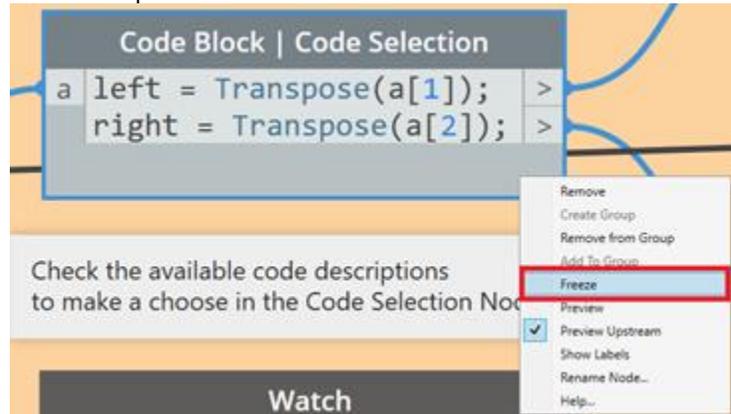


Figure 62: Dynamo allows to control the execution flow of the diagram freezing and un-freezing a node and its downstream connections

15. Select footprint model lines

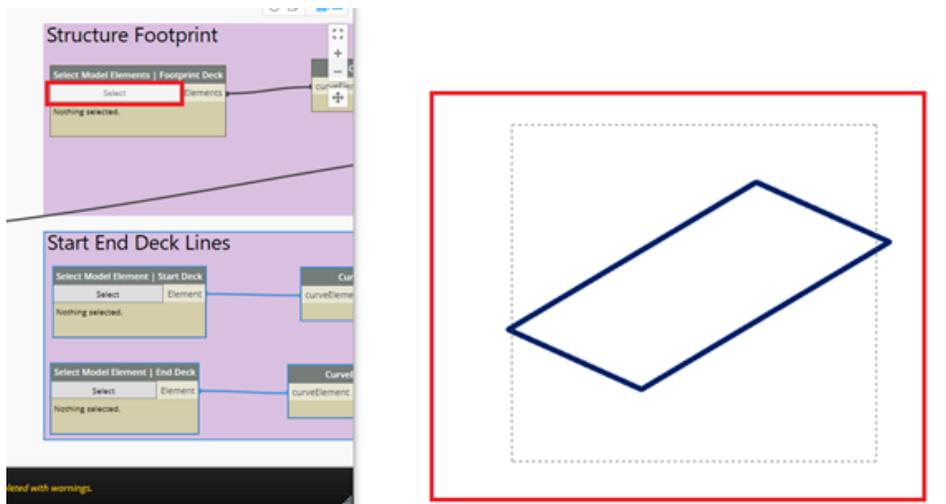


Figure 63: Use the Select Model Elements node to window select multiple object in the Revit model

16. Select start and end lines

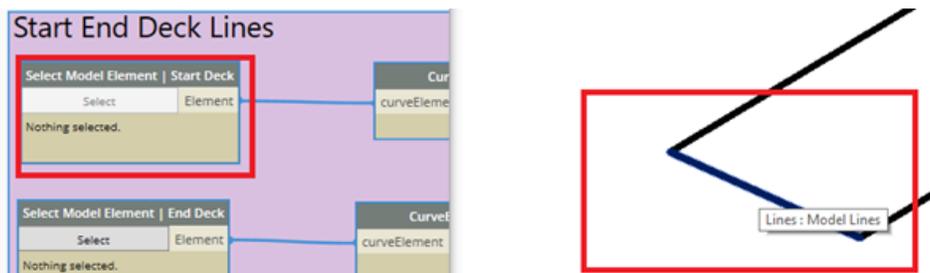


Figure 64: Select start line of the footprint

Excel

19. Start the new Excel input file for the project

Automatic Bridge Template		General Information		Description		Information		Units		
General										
Bridge Length	64	m	Span Footprint Size		Multi Concrete		Concrete C20/27			
Bridge Width	27.00	m	Span Footprint Size		Piles		Concrete Precast C40/50			
Number of Spans	3	(max:12)	Span grade Height		Girders		Concrete Precast C40/50			
Deck										
	Length	Deck Thickness	Inner Girder	Edge Girder	Supports	Top Level Deck	Bottom Level SPD	Crossing Angle	No. of columns	Height Level
	[mm]	[mm]	Type	Type		[mm] regarding N.A.P.	[mm] regarding N.A.P.	[degrees]	[n.] (max:5)	[mm] regarding N.A.P.
Span_1	24.5	5	SXK 8000	SXK 8000	Abutment_1	5000	-200	95.519	0	16000
Span_2	24.5	5	SXK 8000	SXK 8000	Support_1	6000	-5000	95.519	3	16000
Span_3	24.5	200	JXP700	SXK 8750	Support_2	6000	-5000	95.519	3	16000
					Abutment_2	5000	-200	95.519	0	16000
Deck general										
Superelevation	0	%	Span Coordinates		Finish layer [mm]	150				
CapWall_Width	500	mm								
Span Width	28	mm								
Bearing Clearance Height	250	mm								

Figure 69: New Excel spreadsheet to capture design data

The parameters in red cells are not necessary because are derived from the input or the Revit model:

- Span length
- Bridge Width
- Top Elevation
- Rotation supportbeams
- Crossfall

20. Save the spreadsheet with name

Dynamo

21. Run Dynamo Player

22. Start the graph "AU_Viaduct_JSON_MX"

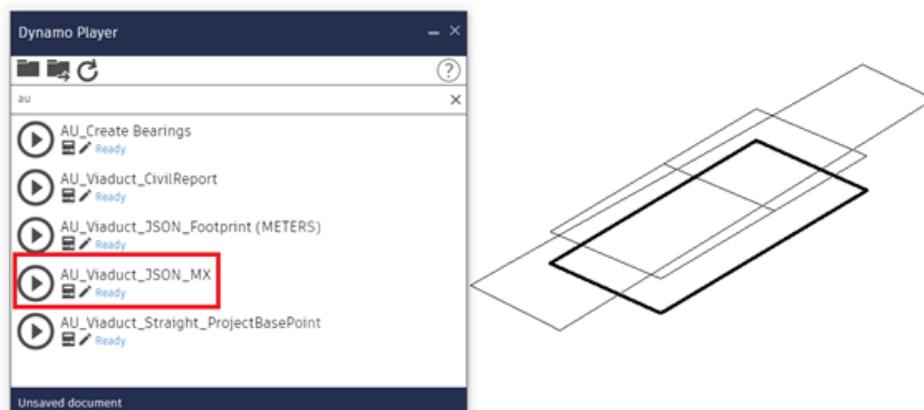


Figure 70: Run the graph with the Revit model setup

- 23. Browse to Excel file
- 24. Browse to JSON file geometry file
- 25. Run graph

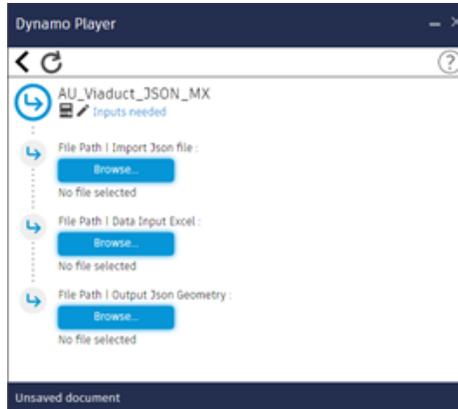


Figure 71: Select the input files



Figure 72: Execute the graph from the Dynamo Player

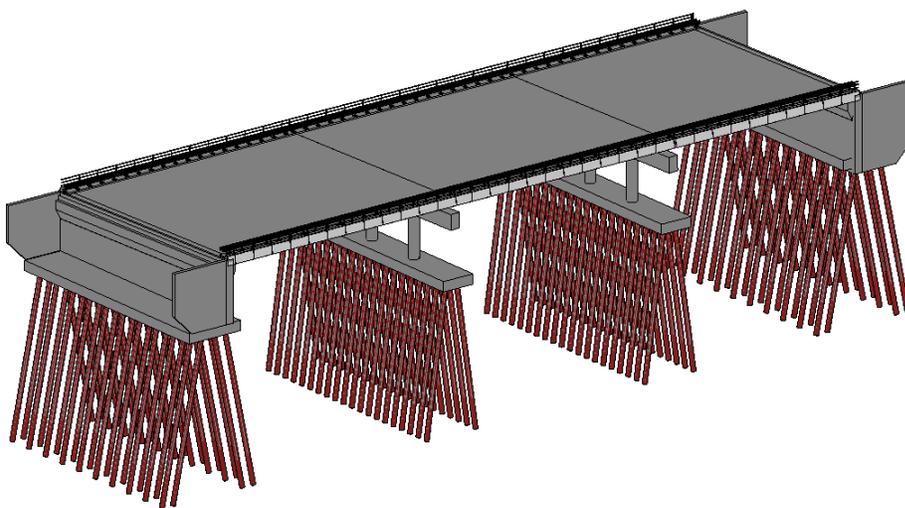


Figure 64 Revit result

About Royal HaskoningDHV

Royal HaskoningDHV is an independent international engineering and project management consultancy leading the way in sustainable development and innovation.

An organization with 6000 employees, 100 permanent offices in more than 30 countries committed to enhance society together.

Royal HaskoningDHV professionals deliver services in the fields of aviation, buildings, energy, industry, infrastructure, maritime, mining, transport, urban and rural development and water.

The organization focuses on delivering added value for the clients while at the same time addressing the challenges that societies are facing. These include the growing world population and the consequences for towns and cities; the demand for clean drinking water, water security and water safety; pressures on traffic and transport; resource availability and demand for energy and waste issues facing industry.

By showing leadership in sustainable development and innovation, together with the clients, Royal HaskoningDHV is becoming part of the solution to a more sustainable society now and into the future.

The organization is driving positive change through innovation and technology, helping clients use resources more efficiently and creating solutions which connect with people to make their lives easier, happier and safer.

Connecting lives is our history and our future. We are connected through a passion to work on projects that matter and to engineer solutions for our clients that go beyond the original brief. We are connected through work that is enhancing society, contributing to a more sustainable future for our children and our children's children.

About Autodesk Consulting Services

Autodesk Consulting advises professionals in the building, infrastructure, manufacturing, and media and entertainment industries on how to stay ahead of the game within an ever-shifting business climate. Autodesk Consulting staff combine industry domain expertise with in-depth technical knowledge of the Autodesk portfolio. Autodesk Consulting specializes in solutions tailored for specific industries:

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- Collaboration and Data Management.
- Smart Manufacturing.
- Visualization.

Autodesk Consulting global team of professionals and network of partners brings together industry-leading best practices and capabilities in business and technology consulting, solution implementation, and custom development. Autodesk Consulting provides enterprise business solutions that help to:

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- Accelerate adoption of new solutions.
- Achieve strategic goals and drive long-term success.
- Manage change with minimal risk.