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

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Royal HaskoningDHV
Revit Specialist

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Autodesk
Implementation Consultant

Join the conversation #AU2017
Agenda

- Introduction
- Inspiration
- Viaduct 1 | Straight + Demo
- Viaduct 2 | Civil 3D Input + Video
- Viaduct 3 | MX Input + Demo
- Next Steps
Introductions
Michel Beliën

- 1988 Drawing Board + CAD
- 1999 First 3D Model
- 2009 Revit (Buildings)
- 2014 Civil Structures
- 2016 Computational Design

- Next 20 years...?
Royal HaskoningDHV

- Maritime & Aviation
- Industry & Buildings
- Transport & Planning
- Water

Royal HaskoningDHV Corporate video

www.royalhaskoningdhv.com

Enhancing Society Together
Royal HaskoningDHV in the World
Consultancy, Engineering & Project Management

Workforce of 6,500 in more than 150 countries

One of the top independently owned engineering companies
Paolo Serra

- 10 years experience in AEC Industry
- Implementation Consultant since 2014
- Focused on BIM Implementations
- Revit, Civil 3D and Dynamo integration
  CivilConnection & CivilPython
- puntorevit.blogspot.com
Dynamo Bridge Design | Matthias Stark AU15

REVITalize Bridge Design | Detailed design

Generate definite and accurate geometry with Dynamo to create detailed design in Revit.

http://au.autodesk.com/au-online/classes-on-demand/class-catalog/2015/revit-for-construction/ci11198#chapter=0
Autodesk | Automate Viaduct Design

- Improve Modelling Efficiency
- Ensure Modelling Consistency
- Enable Structural Analysis

Excel Input → Dynamo Graph → Revit Model → SOFiSTiK Analysis → Revit Rebar
Viaduct 1 | Straight
Viaduct | Precast Girders

- Construction Technology
- Elements Hierarchy
- Design Parameters
- Dynamic Relationships
- Create Models
- Analyze Models
- Produce Design Data
Elements Hierarchy
# Automatic Bridge Template

**Excel Input | Design Parameters**

## Design Parameters

<table>
<thead>
<tr>
<th>Description</th>
<th>Information</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge length</td>
<td>30000</td>
<td>mm</td>
</tr>
<tr>
<td>Bridge Width</td>
<td>11500</td>
<td>mm</td>
</tr>
<tr>
<td>Number of Spans</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

### Deck Spans

<table>
<thead>
<tr>
<th>Span</th>
<th>Deck Thickness</th>
<th>Type</th>
<th>Inner Girder</th>
<th>Edge Girder</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>280</td>
<td>ZIP700</td>
<td>ZIP800</td>
<td>TRN700</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>ZIP1100</td>
<td>ZIP900</td>
<td>TRN900</td>
</tr>
<tr>
<td>3</td>
<td>230</td>
<td>ZIP1500</td>
<td>ZIP1100</td>
<td>TRN1000</td>
</tr>
</tbody>
</table>

**Deck general**

- Superstructure
- Inner Girder Type
- Edge Girder Type
- Cap Wall Width: 300 mm
- Joint Width: 20 mm
- Bearing Clearance Height: 200 mm

### Measurements Abutment Type High

- Front Wall Length: 35950 mm
- Wall Thickness: 1500 mm
- Foundation Slab Width: 3200 mm
- Foundation Slab Thickness: 1500 mm

### Measurements Abutment Type Low

- Wall Thickness: 1500 mm
- Wingwall Length: 4000 mm
- Wingwall Width: 400 mm
- Pile Type: "", Dimension: 1500 mm

### Piles

- Type: "", Location: "", Foundation Width: 2500 mm
- Thickness: 1000 mm

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**Excel Input Sheet**
Automation Parameters

- Spans, No., Lengths, Deck Thickness, Superelevation
- Supports Type, Rotation, Height, Foundation levels
- Girder Types
- And more...

- Elements relationships are captured in the algorithm
- Improve models consistency
Analytical Model | SOFiSTiK
Viaduct Requirements

- Precast Girder Viaduct
- Straight Alignment
- Constant Width
- Fixed Super Elevation
- Excel Input Parameters
- Structural Analysis
- Design Data
Tell me how you want it!
- Bridge Width
- Amount of spans?
- Span lengths?

Viaduct 1 | Interactive

- Excel Input
- Dynamo Player
- Revit Model
- Design Data
## Automatic Bridge Template

### General Information for Lengths

<table>
<thead>
<tr>
<th>Description</th>
<th>Information</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over Length</td>
<td>30000 mm</td>
<td></td>
</tr>
<tr>
<td>Bridge Width</td>
<td>250 mm</td>
<td></td>
</tr>
<tr>
<td>Number of Points</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

### Deck General

<table>
<thead>
<tr>
<th>Span</th>
<th>Length [mm]</th>
<th>Deck Thickness</th>
<th>Type</th>
<th>Type</th>
<th>Supports</th>
<th>Top Level Deck [mm]</th>
<th>Bottom Level SFD [mm]</th>
<th>Crossing Angle [degrees]</th>
<th>No. of Columns</th>
<th>Finish Level [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span_1</td>
<td>10000</td>
<td>250</td>
<td>TIP300</td>
<td>TJ9000</td>
<td>Adjustable_1</td>
<td>4550</td>
<td>3200</td>
<td>90</td>
<td>3</td>
<td>-19000</td>
</tr>
<tr>
<td>Span_2</td>
<td>15000</td>
<td>250</td>
<td>TIP300</td>
<td>TJ9000</td>
<td>Adjustable_1</td>
<td>4550</td>
<td>3200</td>
<td>90</td>
<td>3</td>
<td>-19000</td>
</tr>
</tbody>
</table>
I think a “list.reverse” node or one “flatten” node too many
Automation | Deck

- Concrete Deck (topping)
- Sloped element
- Enable structural analysis

- Excel Input
- DS + Python Script
- Revit Slab
Automation | Girders

- Precast Girders
- Correct Representation
- Enable Structural Analysis

- Calculate Amount and Location
- Dynamo + DS + Python Script
- Structural Framing
Automation | Cap Walls

- Cast-In-Place connections
- Non-Structural

- Calculate Shape and Location
- Dynamo + Python Script
- Wall (non-structural)
Automation | Abutments

- Cast-In-Place Walls
- High / Low Types
- Enable Structural Analysis

- Calculate Shape and Location
- Dynamo + Python Script
- Wall (structural)
Automation | Supports

- Cast-In-Place Beams / Columns
- Variable No. Columns
- Enable Structural Analysis
- Derive Location from Supports
- Dynamo
- Structural Framing / Columns
Automation | Foundations

- Cast-In-Place Slabs + Precast Piles
- Variable No. Piles + Variable Elevations
- Enable Structural Analysis
- Calculate Shape and Location
- Dynamo
- “Structural Columns”
- Foundation Slabs
Automation | Architectural Elements

- Shoulders, Barriers, Rails, Edge Elements
- Fixed Dimensions, Element types
- Calculate Shape and Location
- Python + Dynamo
- Adaptive Components
- Infinitely rigid connections and springs
- Auxiliary Cross-section
- Calculate Elements and Location
- Dynamo + DS + Python Script
- Structural Framing + Excel output
Curved Viaducts

- Follow Civil 3D Alignment
- Corridor Points Report
- Support Stations
- Export to SOFiSTiK
Curved Viaduct | Multi Cross-Section

- MX Alignment
- Deck Footprint
- Support Grids
- JSON file
- Excel input
Next Steps
Next Steps | New Configurations

- New Girder Layout Rules
- New Deck Cross-Section
- Crown Road
Next Steps | Optimize, Scale & Grow

- Optimize Script(s)
- Re-Configuration (viaduct components)
- Dynamo Player (deployment)
- Excel File (guided wizard)

Job Opportunities
- Software Engineers (NL, UK, SA, Indonesia)
Next Steps | CivilConnection

- Common Language for Linear Structures
- Linear Coordinate Systems
- Lean Workflows
- Information Interoperability
QUESTIONS

def Closing(questions : int)
{
    answers = {};  
    [Imperative]
    {
        if(questions > 0)
        {
            for (i in 0..questions)
            {
                answers[i] = "Next!";
            }
        }
        answers[Count(answers)] = "Thanks for your attention!";
    }
    return = answers;
};
THANKS! (For real)