

Case study: Bridges: Rhino-Tekla-Trimble Connect

NÁRODNÁ BIM KONFERENCIA

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About Author



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Pavel holds a master degree from Faculty of Civil Engineering of Czech Technical University in Prague. He is a BIM / VDC manager, active member of ČKAIT (Czech Chamber of Chartered Engineers and Technicians Engaged in Construction Authorization), czBIM (Czech BIM Council) and external reviewer of ČAS (Czech Standardization Agency). He supports and promotes OPENBIM-based philosophy and workflows and open standards and formats such as IFC, cloud-based CDE (Common Data Environment) and Mixed Reality (HoloLens) in the field of design and construction. Concrete monolithic and prefabricated structures rank among his other professional interests. Pavel has been collaborating with various software, design and construction companies, both national and international. Currently, he works at AFRY CZ s.r.o. as BIM / VDC manager. He is responsible for creating strategy and implementation in BIM / VDC. He has also been involved in a number of research projects.

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- Master degree: CTU in Prague – End 02/2021
- Bridge designer in AFRY CZ since 06/2018

BIM key points AFRY CZ

OpenBIM

- Implementation and support of the transition from closed BIM to Open BIM
- The standard for OpenBIM communication is the IFC data format (ČSN EN ISO 16739)
- Communication via Common Data Environment (CDE) ISO 19650

Digital Building Permit (1.7.2023)

- Information BIM models in IFC 4.x format with attributes according to the data standard of the building information model (CAS/SFDI) will be required within the Digital Building Permit

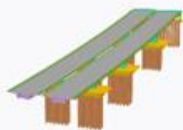
Creation of a Data Standard of the State Fund for Transport Infrastructure of the Czech Republic (DS SFDI)

- AFRY CZ (David Novák, Pavel Vlasák) is one of the authors of DS SFDI

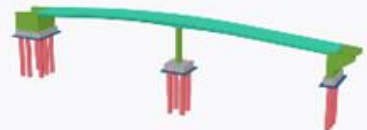
Model-based projects (Drawing-free project)

- A new generation of support for construction companies
- Better options for automation of project work
- Drawings are often country-specific, while BIM model information is more universal to make cross-border collaboration easier

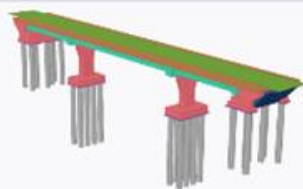
Examples of BrIM workflow in AFRY CZ



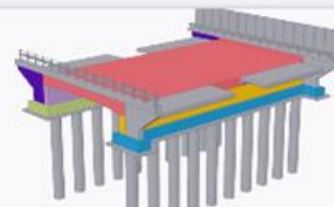
D0_511_SO201.ifc



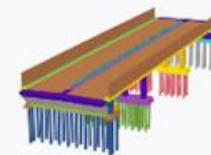
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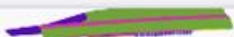
D35_Opatovice_Casy_SO225.ifc



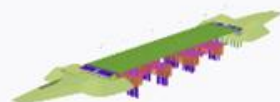
D35_Sadova_plotiste_SO202.ifc



D35_Sadova_plotiste_SO204.ifc



D3_Sanace_sesuvu.ifc



D3_SO204.ifc



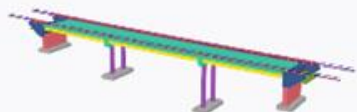
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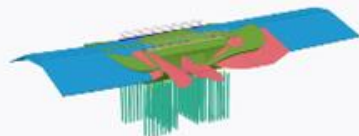
D52_Nove_mlyny_SO220_a_SO240...



E39_Norway_K400.ifc



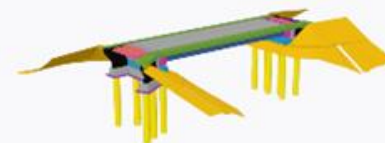
E39_Norway_K600.ifc



Horni_jiretin_SO203.ifc



III_24513_Rostoklaty_SO001.ifc



III_24513_Rostoklaty_SO201.ifc

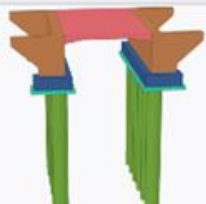


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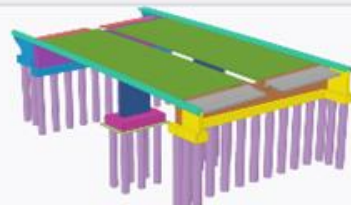
Examples of BrIM workflow in AFRY CZ



Il_150_Otradovice_SO201.ifc



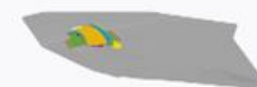
Il_201_Belec_SO201.ifc



I_13_Kladrubska_spojka_SO203.ifc



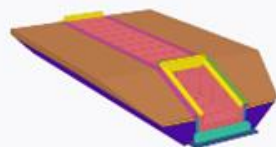
I_13_Kladrubska_spojka_SO204.ifc



I_19_Pocaply_SO201.ifc



I_3_Cervene_vrsky_SO202_Data.ifc



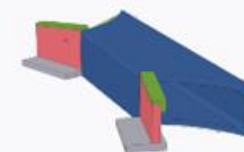
I_3_Cervene_vrsky_SO_201.ifc



I_3_Cervene_vrsky_SO_203.ifc



I_3_Cervene_vrsky_SO_204.ifc



Levobrezni_SO201.ifc



podchod_ruz-kla_SO_02-20-01.ifc

Bridge Information Modeling (BrIM) based on OpenBIM

A. Voluntary for own project needs

- 3D / BIM is extremely illustrative, decrease RFI (One image is more than 1000 words and one model is more than 1000 images.)
- OpenBIM-based standardization (IFC - ISO 16739; CDE ISO 19650) enables automation and efficiency
- Quality improvement

B. Mandatory for the contracting authority

- compliance with state requirements (BIM protocol, IFC incl. SFDI Data Standard, CDE) is necessary to win public contracts

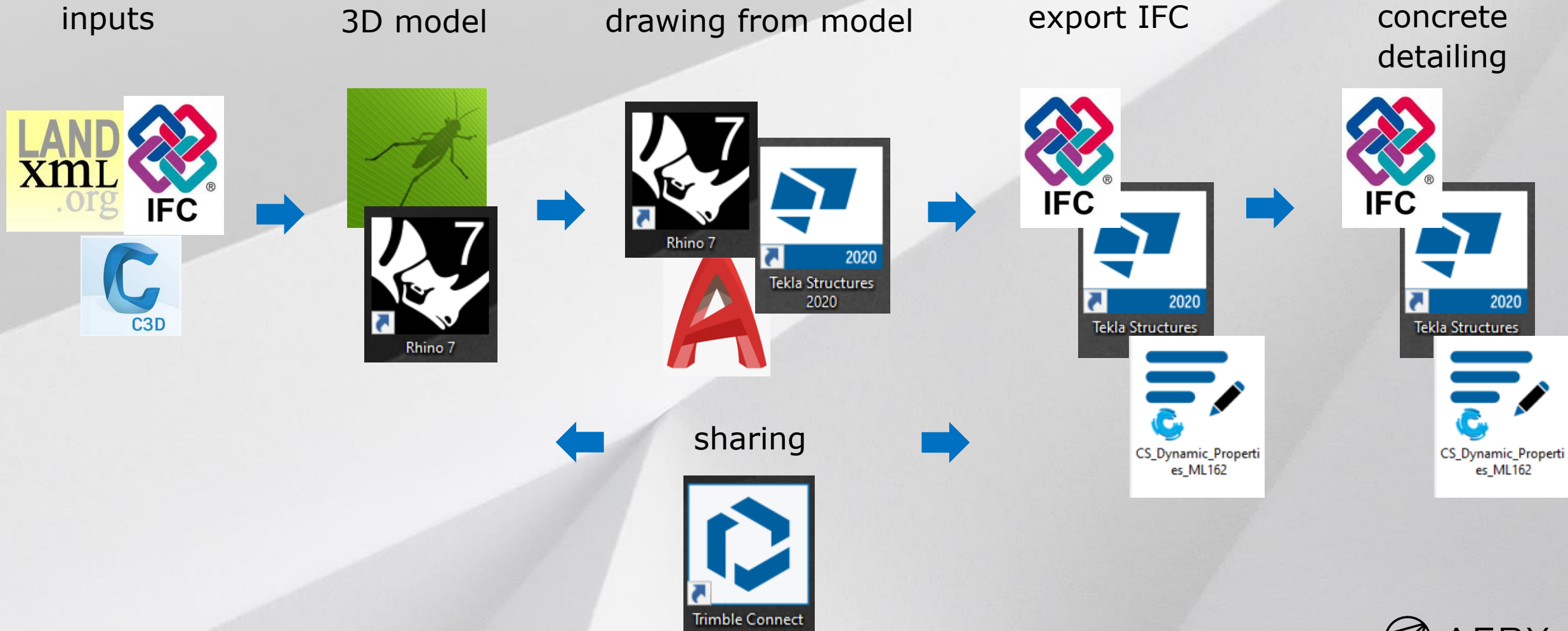
C. Voluntary to support implementation in order to win new contracts

- preparation for [Model-based projects \(Drawing-free project\)](#)
- the ability to be a partner and leader for construction companies at home and abroad
- [drawings are national specific, BIM models are international](#)

Description of BrIM workflow in AFRY CZ

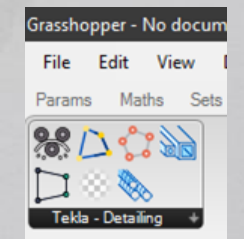
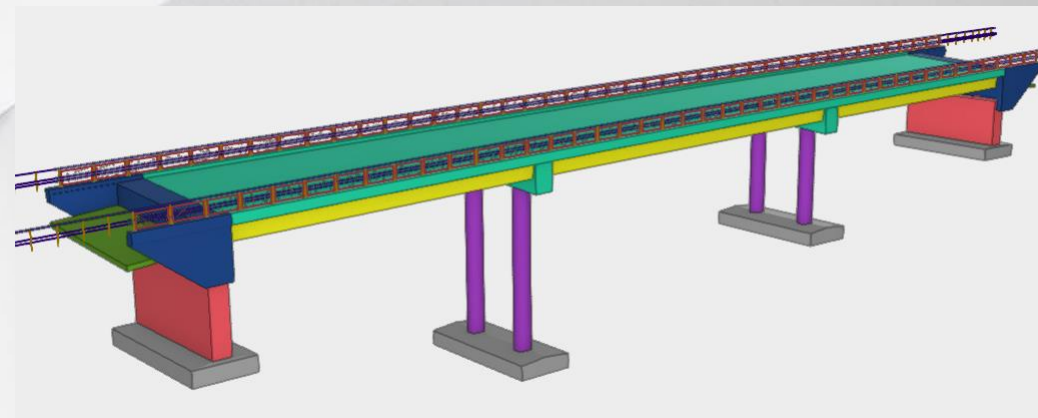
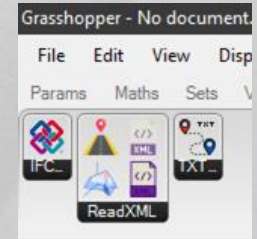
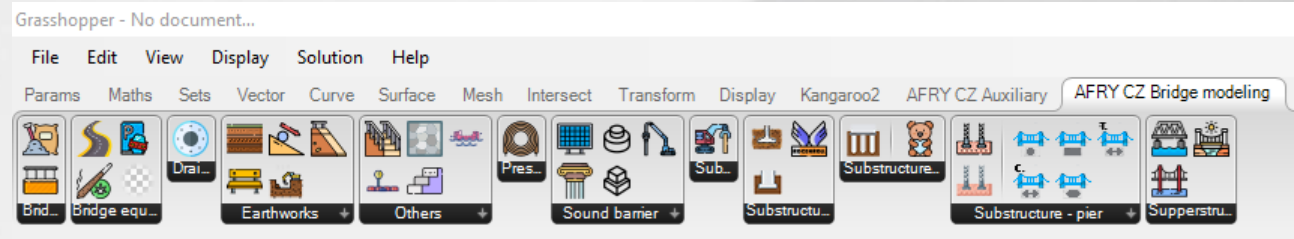
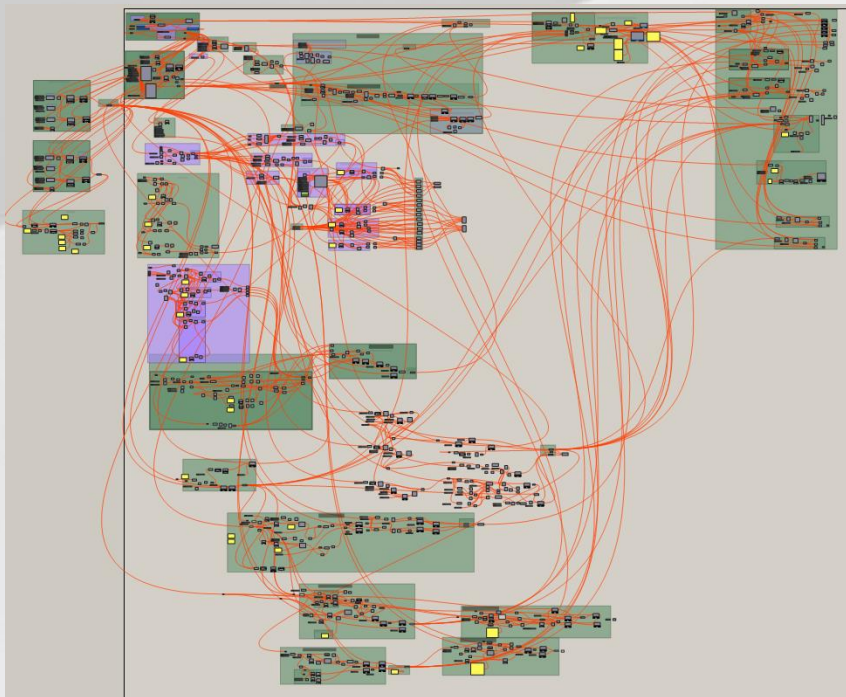
- ❑ suitable inputs (*LandXML, IFC e.g. from AutoCAD Civil 3D*)
- ❑ design of construction in 3D (*Rhino 7 with Grasshopper - algorithmic modeling for Rhino*)
- ❑ creation of 2D drawings from the model (*Rhino 7, Autocad, Tekla Structures*)
- ❑ export of the structure to the required format (*IFC incl. DS SFDI*) (*Tekla Structures*)
- ❑ detailing concrete parts (*Tekla Structures*)
- ❑ Sharing (*CDE*) (*Trimble Connect*)
- ❑ Augmented reality (*AR*) (*Trimble SiteVision*), Mixed reality *MR* (*Trimble Connect for Mixed Reality, HoloLens 2 or XR10*)

Description of BrIM workflow in AFRY CZ



Construction model creation

- ❑ common procedure in Rhinoceros (traditional 3D modeling)
- ❑ use of parametric module and computational design
- ❑ combination of graphic and non-graphic programming (creation of own plugins)

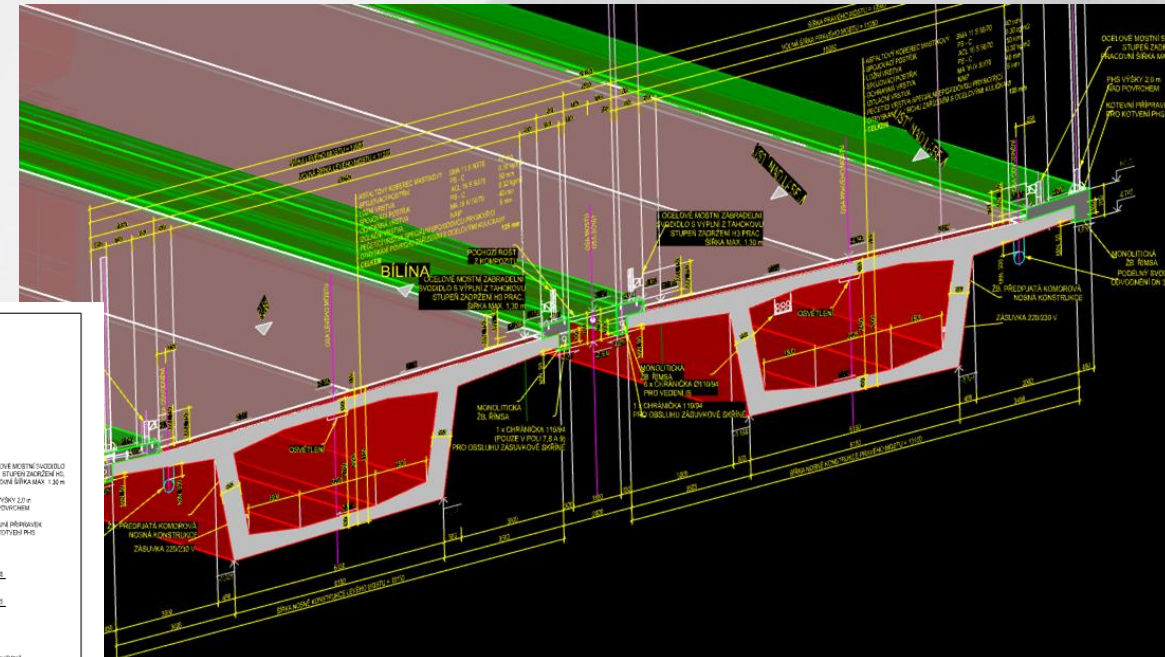
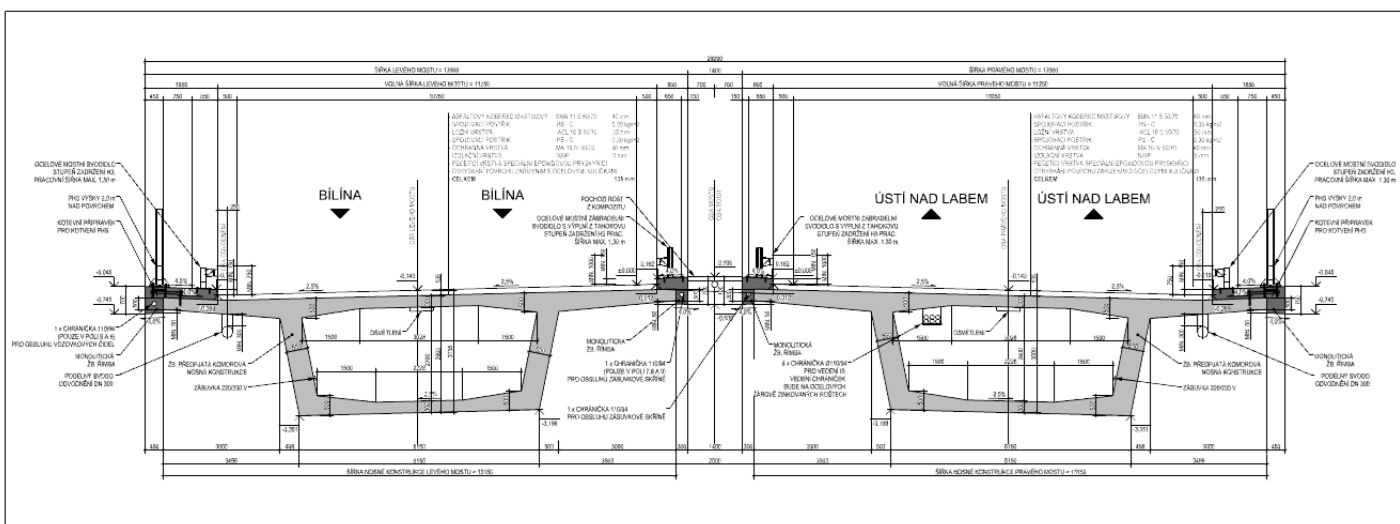


Construction model creation

- ❑ video with a sample of the railing
- ❑ https://www.linkedin.com/posts/pavel-vlas%C3%A1k-75b63552_learnbydoing-happydesignerbetterresult-activity-6872438243095281664-h9sZ?utm_source=share&utm_medium=member_desktop

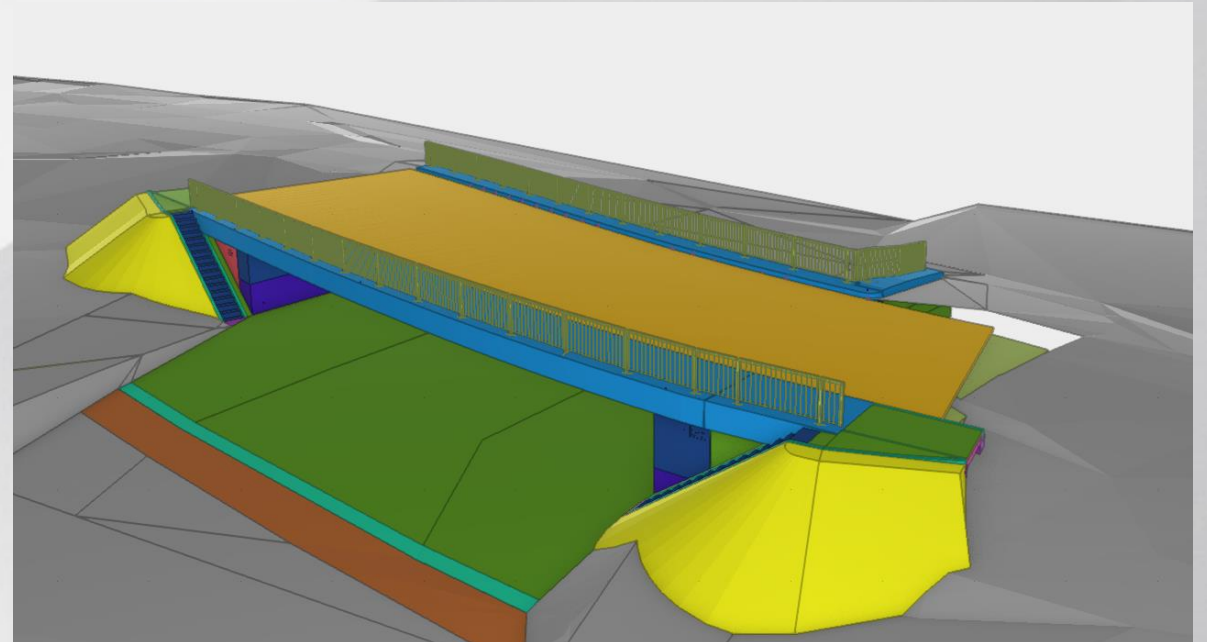
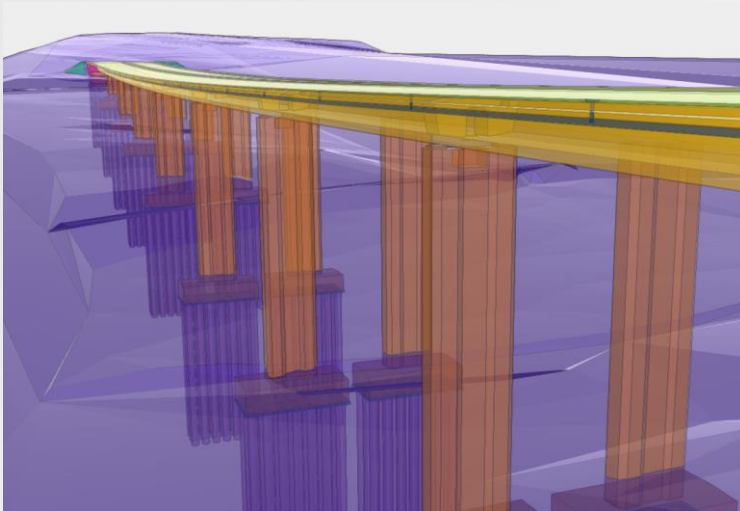
Creation of drawings

- ❑ drawings resp. geometries are created directly from the 3D model
- ❑ drawings resp. geometries are located on proper place in 3D space
- ❑ manual dimensioning and description



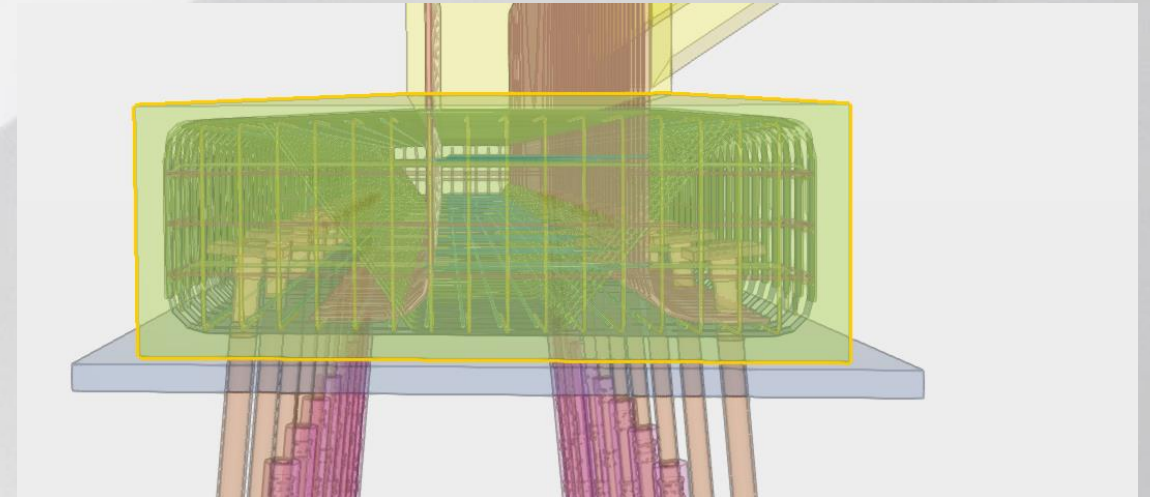
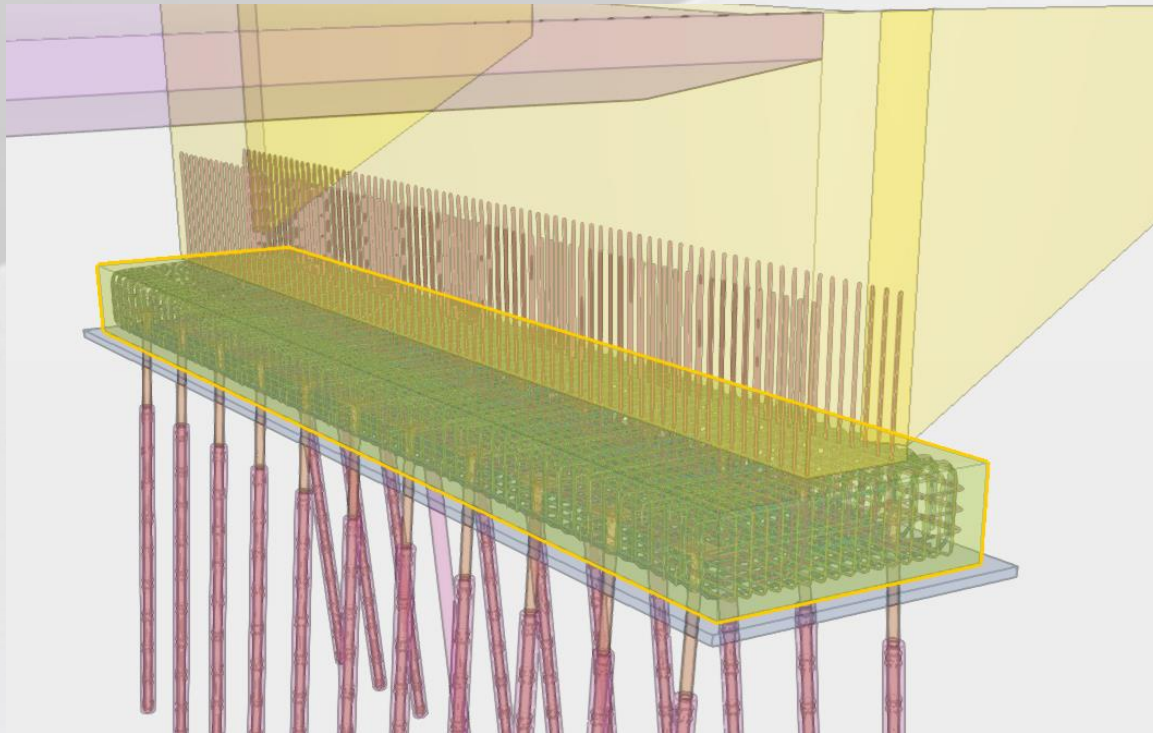
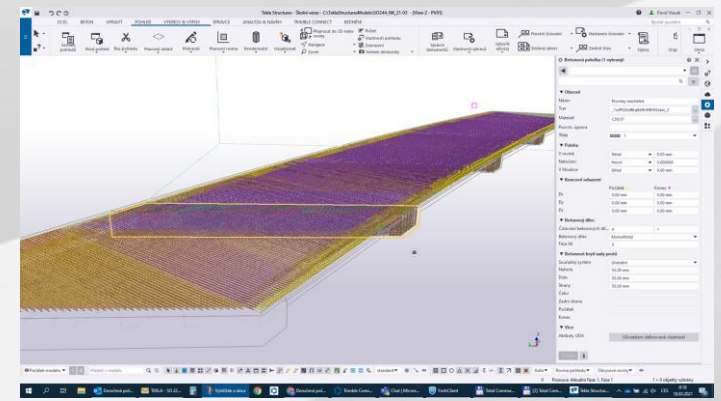
Export of construction to IFC format incl. non-graphic information DS SFDI (LOI)

- ❑ custom plugins for Rhino 7 with Grasshopper
- ❑ DS SFDI (LOI) connection in Excel and Dynamic_Properties plugin (Construsoft). This combination allows the user to define any standard, not just CZ. (*Rhino, GH, Tekla Structures, Dynamic_Properties*)
- ❑ own export to IFC (*Tekla Structures*)



Reinforcement construction

- ❑ use of Tekla Structures functionalities
- ❑ preservation of model parameters (*Rhino, GH, Tekla Structures, Dynamic_Properties*)
- ❑ own export of reinforcement to IFC (*Tekla Structures*)



Bridge Information Modeling (BrIM) - reinforcement

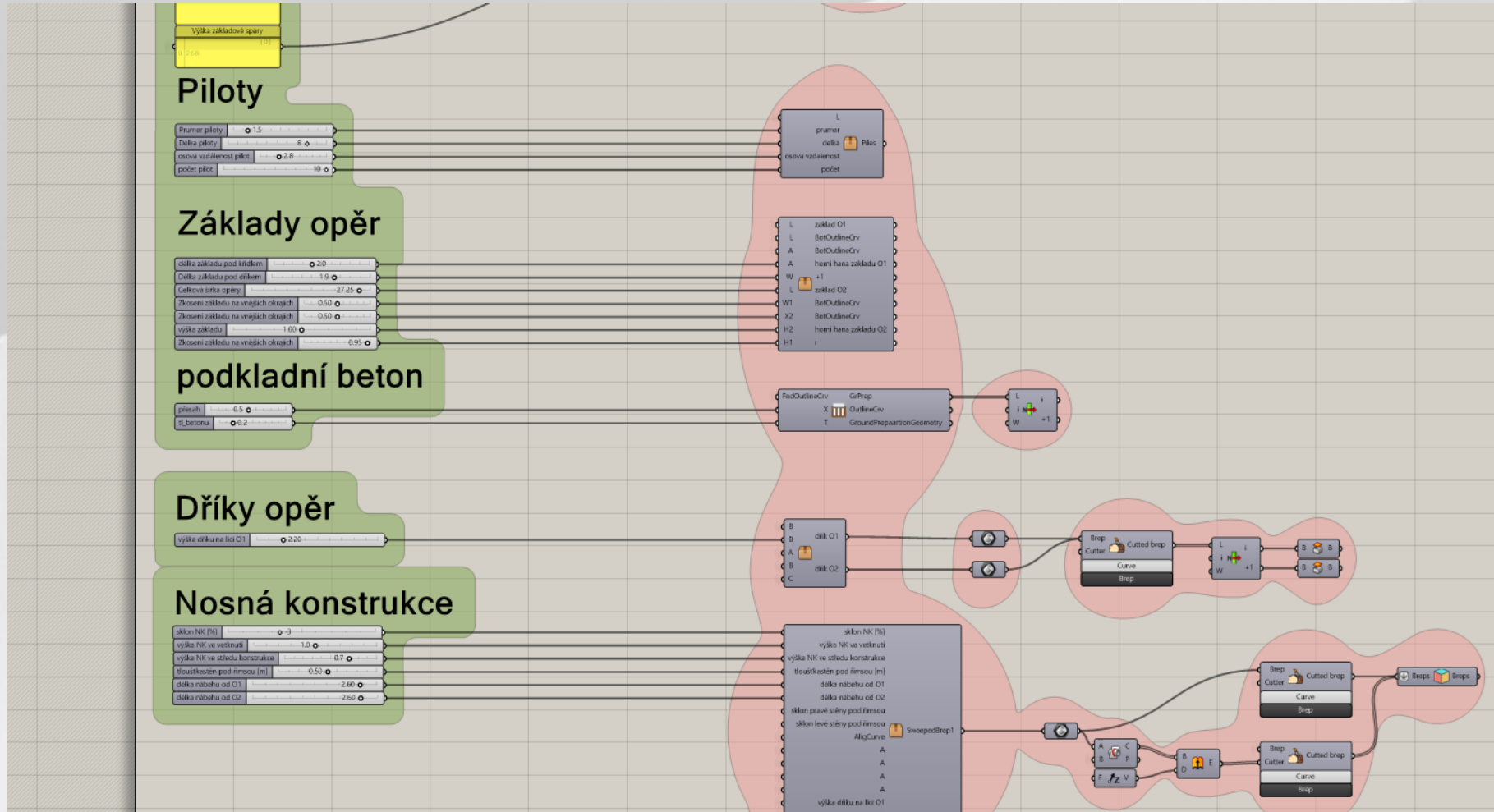
A. Reinforcement

- detailing concrete parts (Tekla Structures)

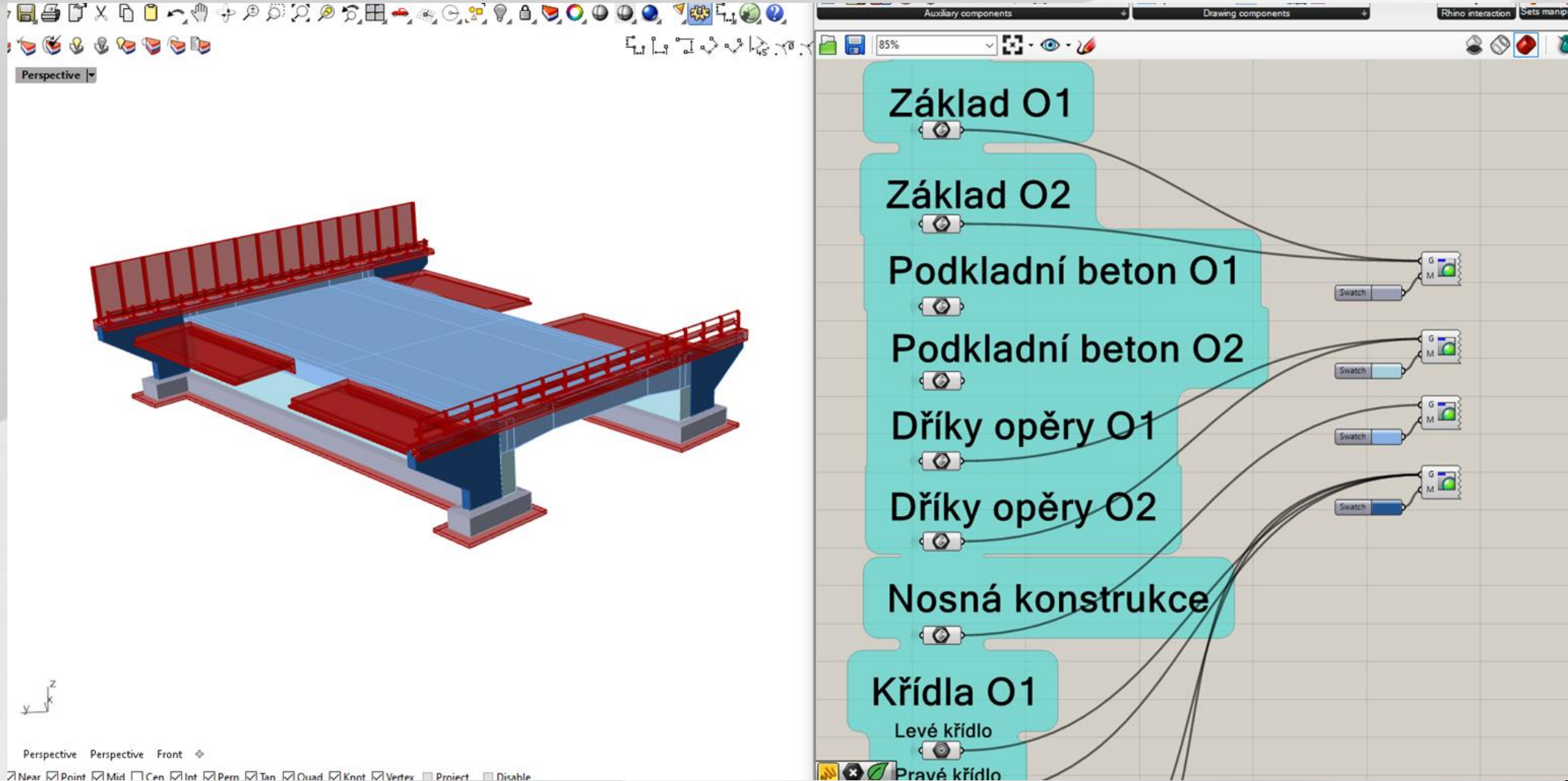
B. Parametric reinforcement

- detailing concrete parts (Rhino 7 with Grasshopper - algorithmic modeling for Rhino, Tekla Structures)
- combination of graphic and non-graphic programming (creation of own plugins)

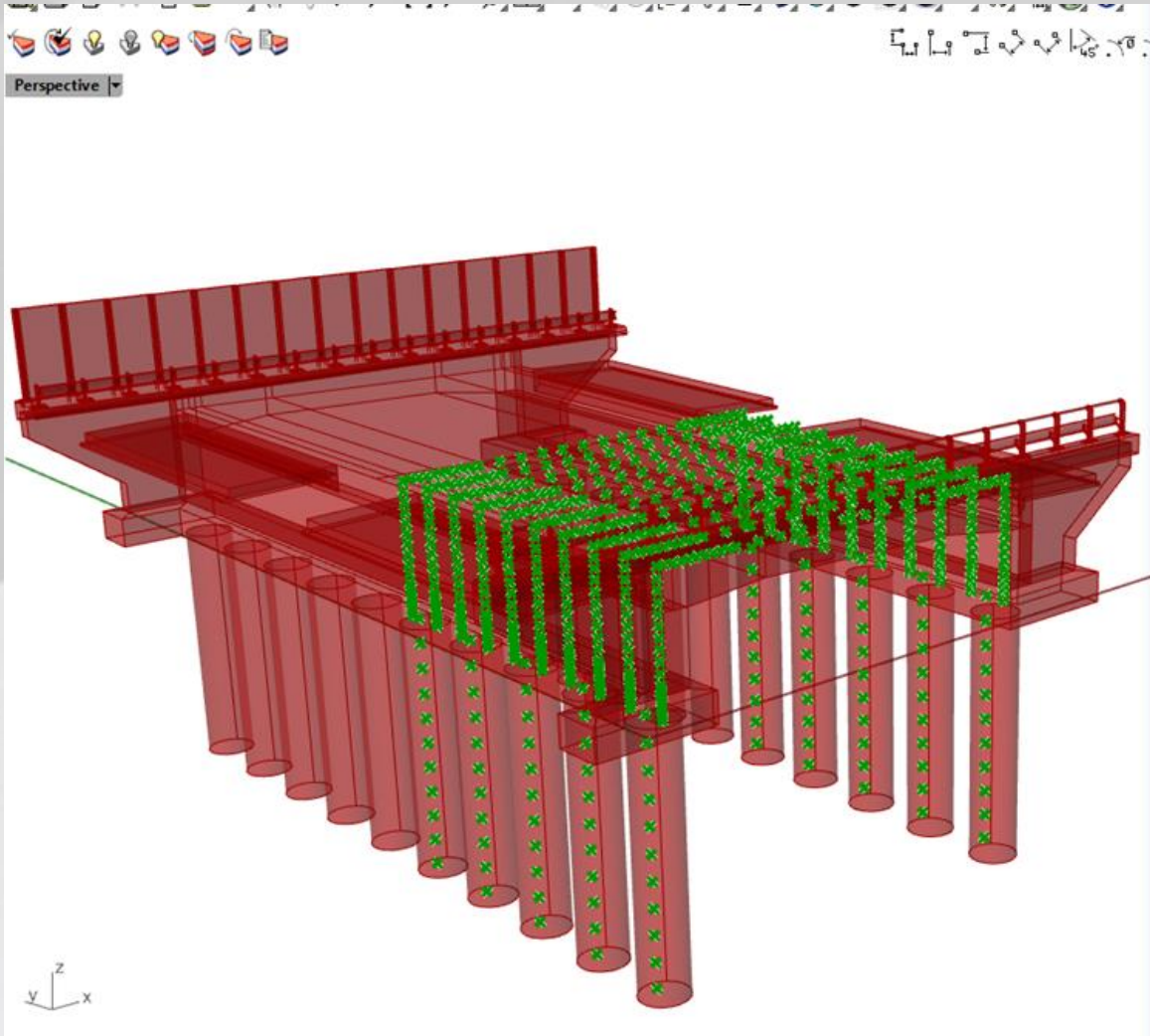
Input specifications and necessary calculations for creating bridge elements



Possibility to set the display of bridge elements



Extraction of FEM element coordinates for Midas

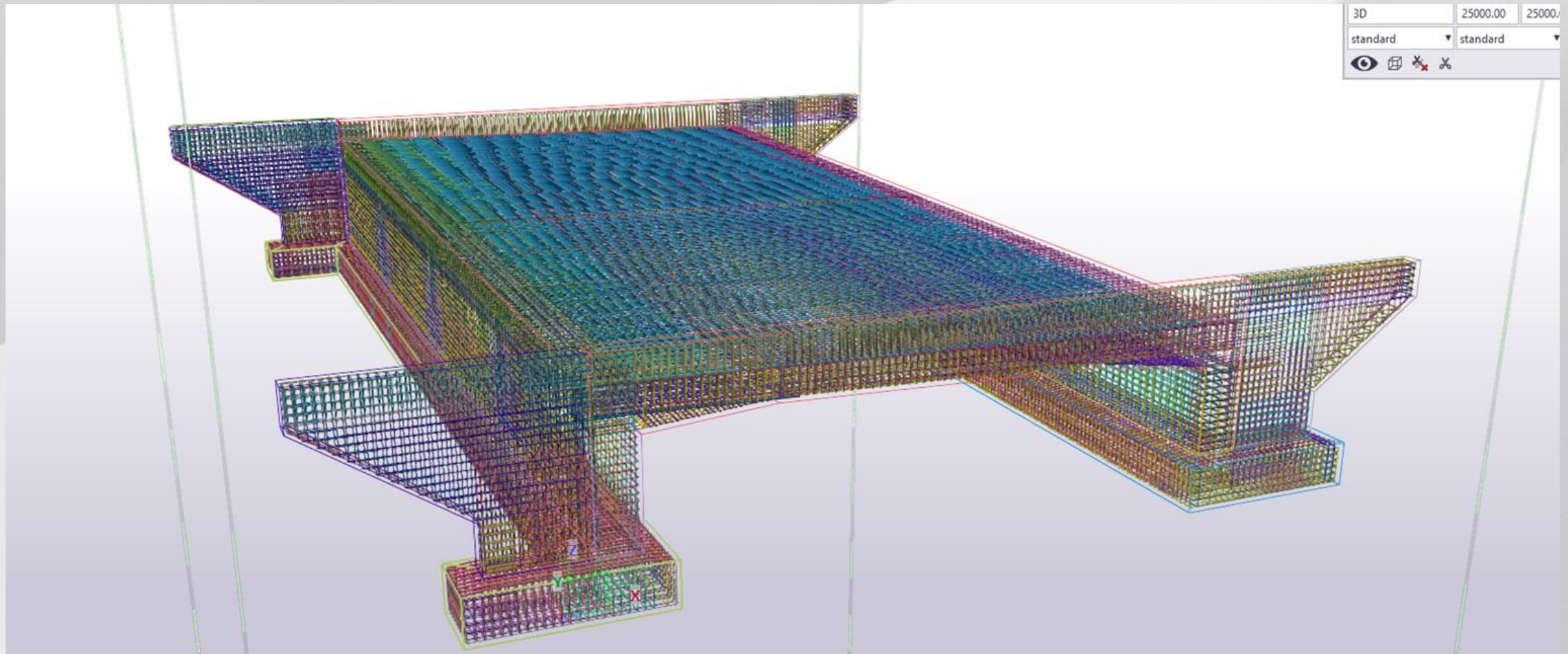


Midas - body 1/2 konstrukce

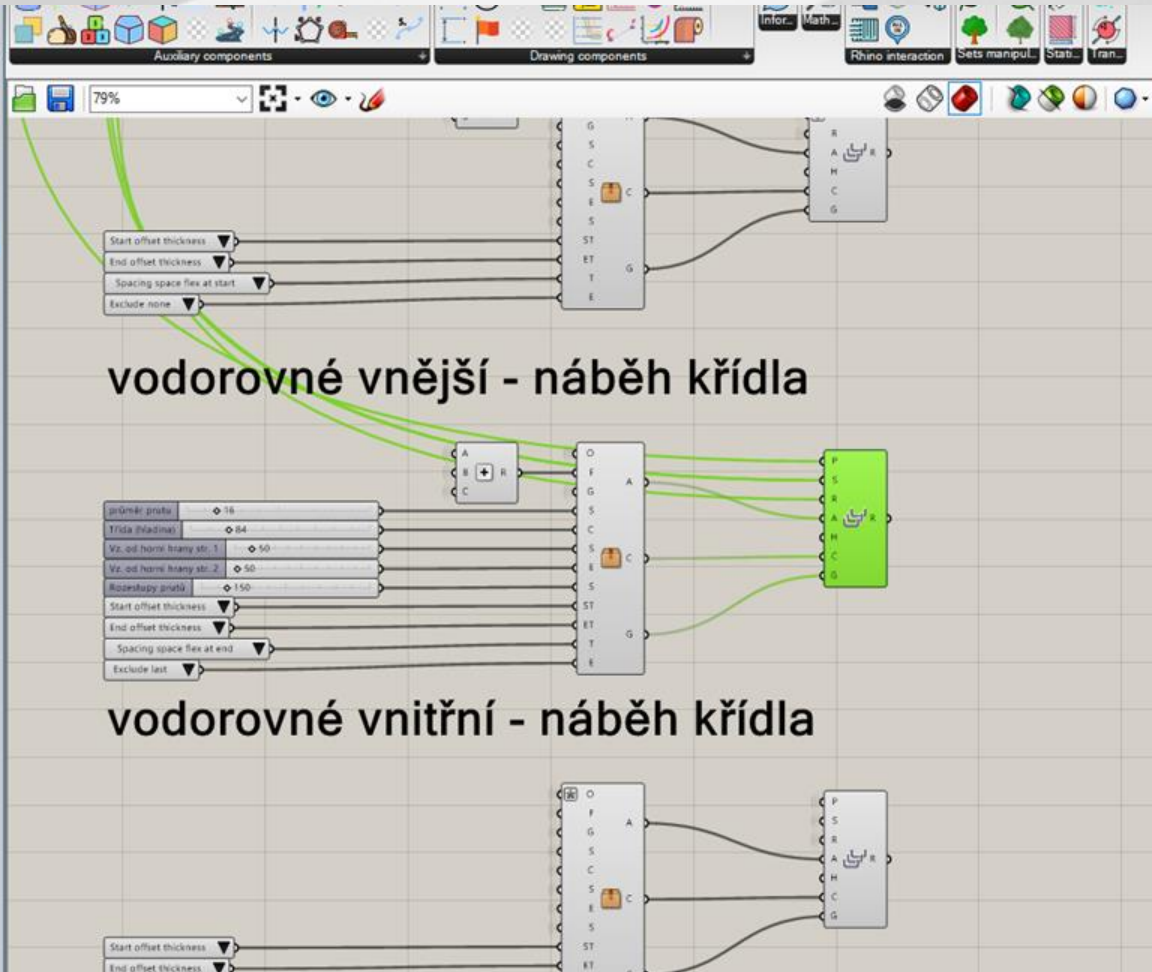
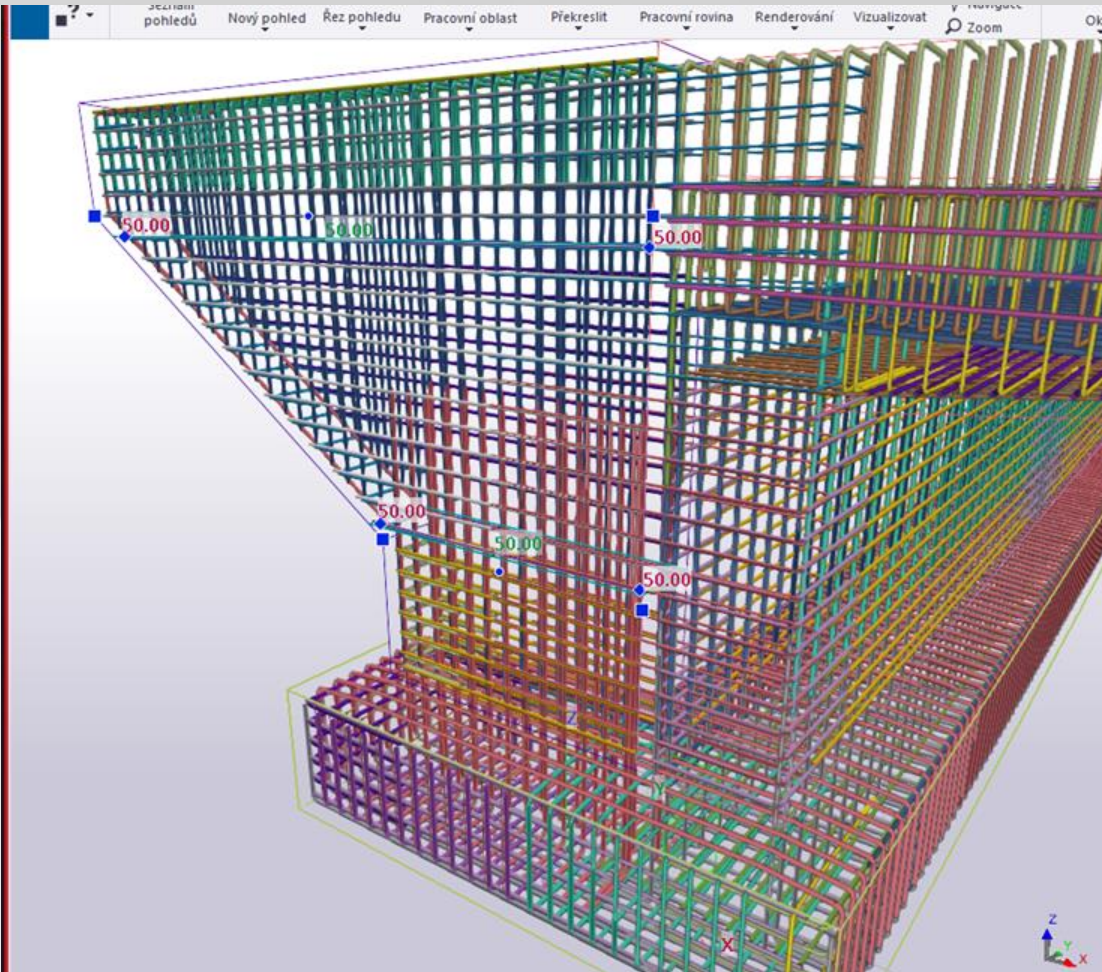
The screenshot shows the Midas software interface. On the left, a list of parameters is displayed, including 'rozdeleni' (10), 'deka_pilota' (O1), 'sirka_z' (O1_zaklad), 'vyska_z' (O2), 'drik_O1' (O2_zaklad), 'sklon_NK' (mostik), 's_NK_vetknuti' (nabeh_O1_a), 'rozpeti' (nabeh_O2_a), 'nabeh_O1' (pilota_O1), and 'nabeh_O2' (pilota_O2). These parameters are connected to a central 'Pt' block. To the right, a list of 28 points is shown, each with its coordinates (x, y, z). An 'Export' button is located below the list.

Point ID	x	y	z
0	0.95	1.4	0
1	0.95	1.4	-0.5
2	0.95	1.4	-1.6
3	0.95	1.4	-2.4
4	0.95	1.4	-3.2
5	0.95	1.4	-4
6	0.95	1.4	-4.5
7	0.95	1.4	-5.6
8	0.95	1.4	-6.4
9	0.95	1.4	-7.2
10	0.95	1.4	-8
11	12.05	1.4	0.387
12	12.05	1.4	-0.413
13	12.05	1.4	-1.213
14	12.05	1.4	-2.013
15	12.05	1.4	-2.813
16	12.05	1.4	-3.613
17	12.05	1.4	-4.413
18	12.05	1.4	-5.213
19	12.05	1.4	-6.013
20	12.05	1.4	-6.813
21	12.05	1.4	-7.613
22	0.95	0.60125	0
23	0.95	0.60125	0.1
24	0.95	0.60125	0.2
25	0.95	0.60125	0.3
26	0.95	0.60125	0.4
27	0.95	0.60125	0.5

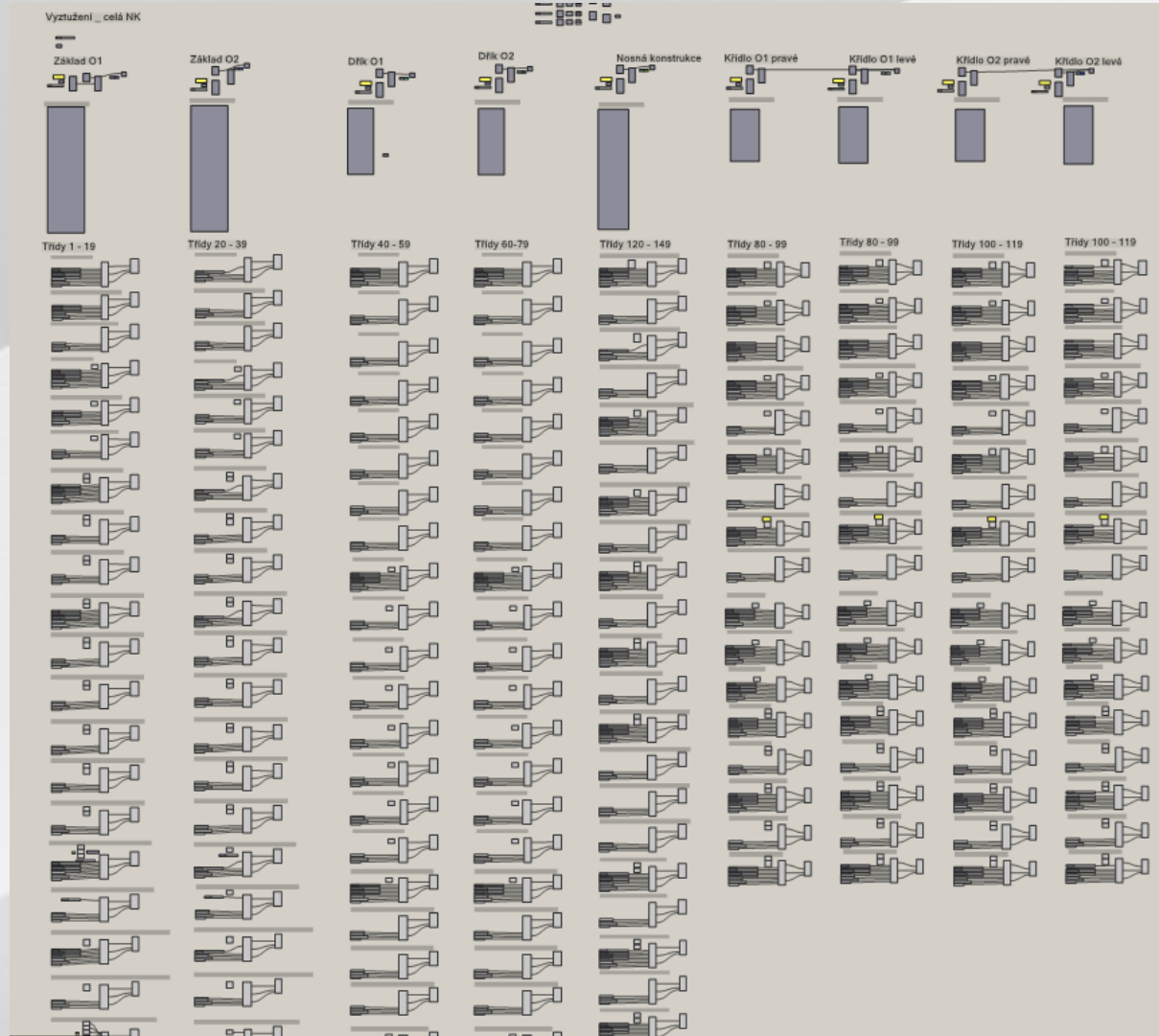
Completely parametrically reinforced bridge using Rhino, GH, Tekla Structures - overview



Completely parametrically reinforced bridge using Rhino, GH, Tekla Structures - detail

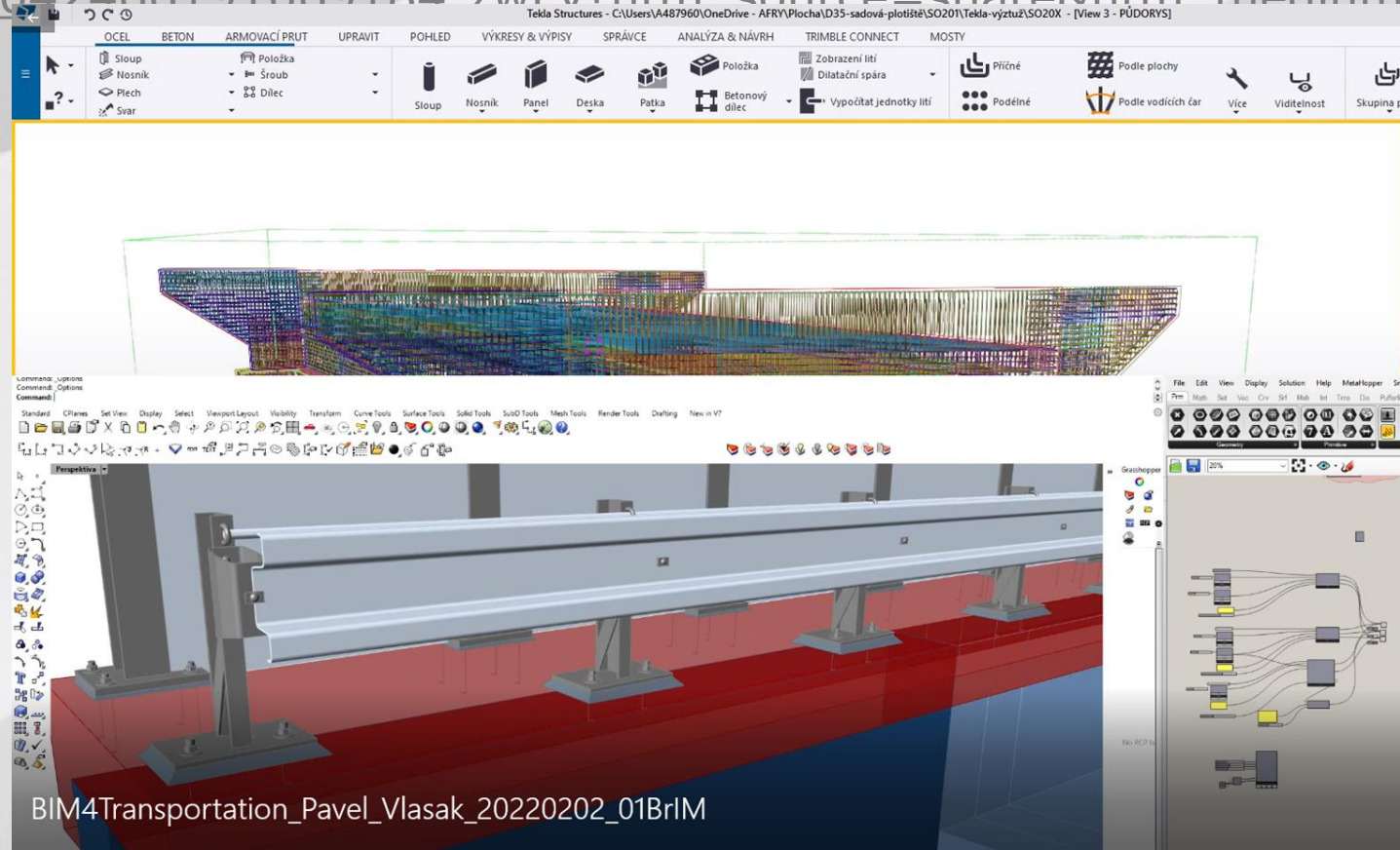


Part of parametric reinforcement in GH

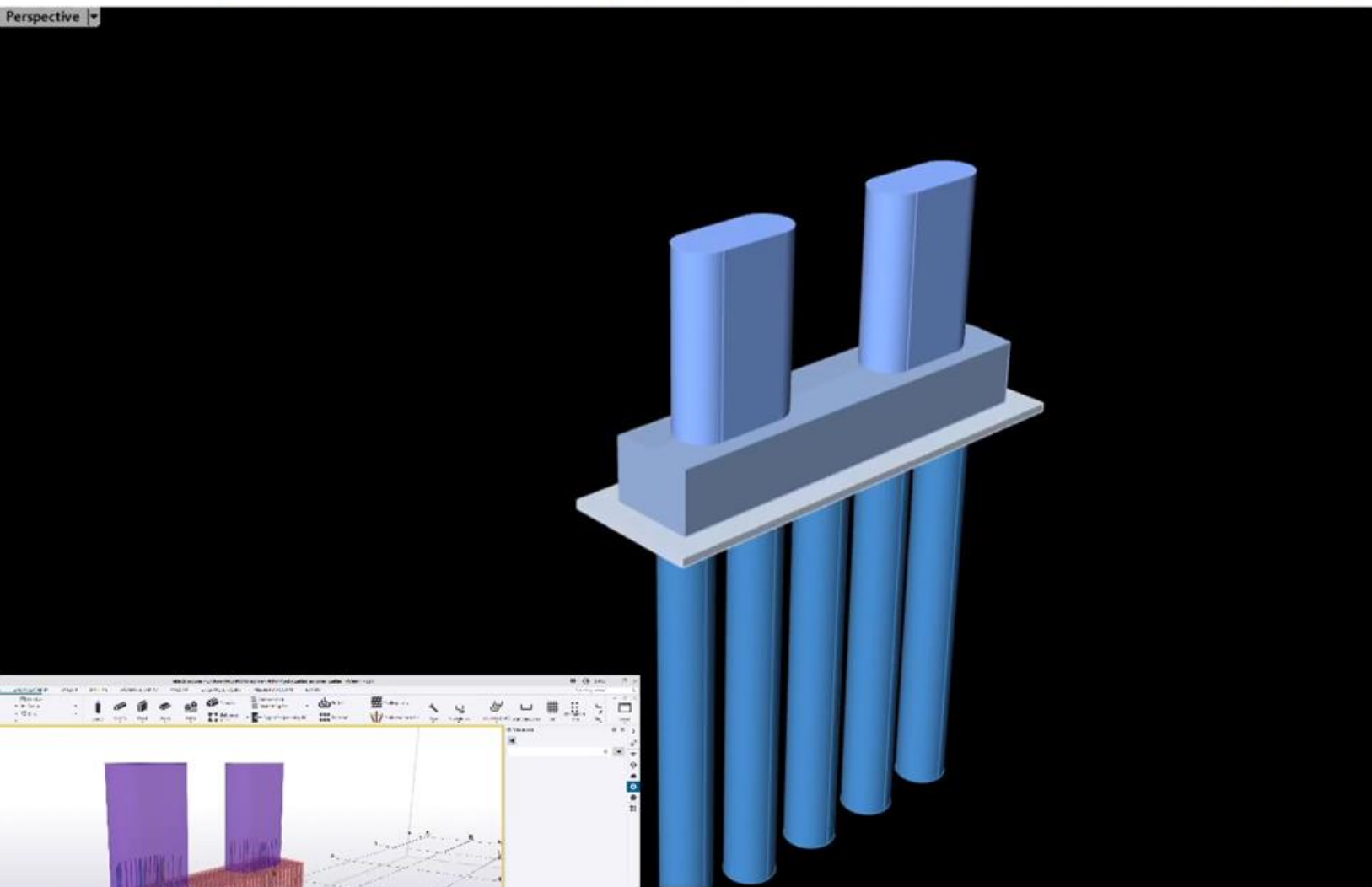


Detailing concrete parts – parametric reinforcement

- ❑ video with a sample of the parametric reinforcement
- ❑ https://www.linkedin.com/posts/pavel-vlas%C3%A1k-75b63552_teklastructures-rhinosg-activity-6903047466191069184-zwFv?utm_source=share&utm_medium=member_desktop

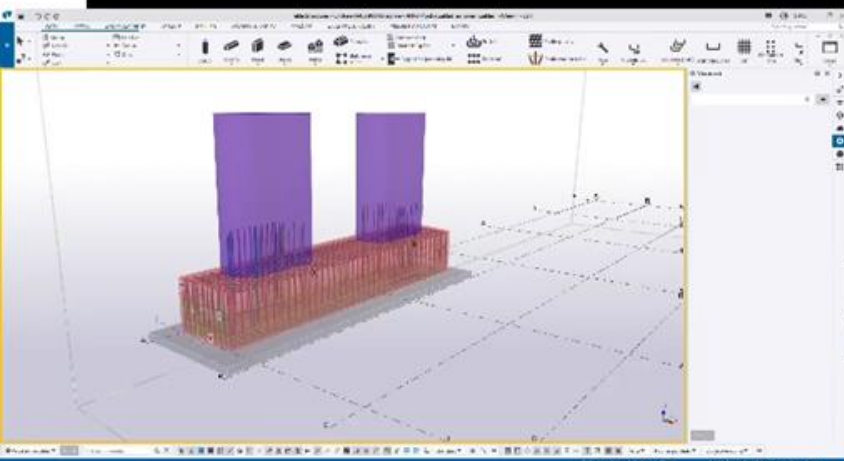


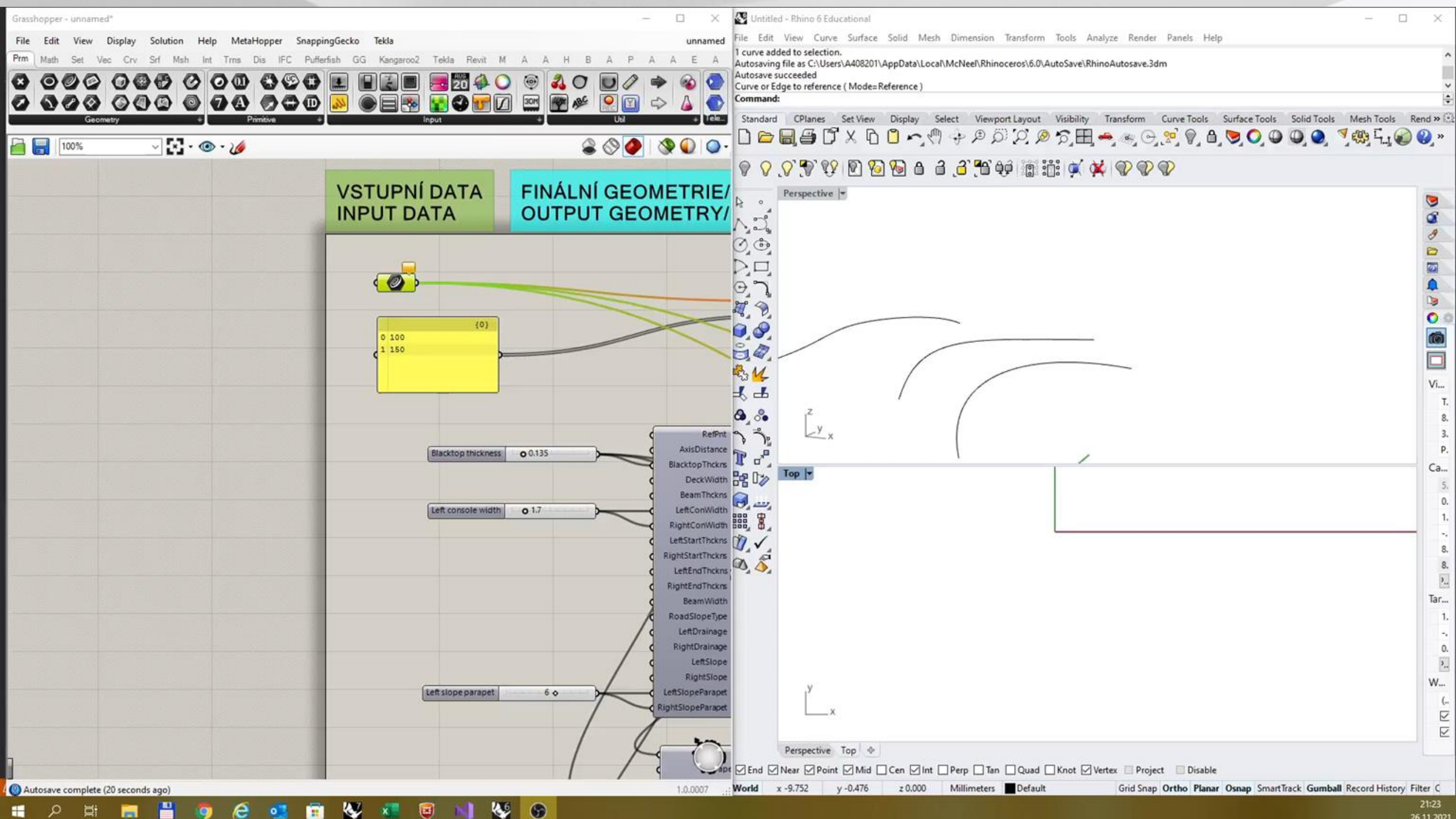
Command: _Delete



Grasshopper

- Podkladní beton
 - Odsazení: 0.6
 - Tloušťka: 0.2
- Základ
 - délka_základu: 9.5
 - šířka_základu: 2
 - vyska_základu: 1.5
 - vyska_nabehu_základu: 1.45
- Pilíře
 - Osová vzdálenost pilířů: 5.3
 - šířka pilíře: 2.8
 - Tloušťka pilíře: 1.2
- piloty
 - 1.925 (osová vzdálenost pilot)
 - 1.2 (Průměr pilot)
 - délka pilot: 10
- Vytvoření výkresů
 - Vytvořit výkres
- Aktualizace Excelu
 - Aktualizace excelu
- New Group
 - Zhasnout konstrukci





VSTUPNÍ DATA INPUT DATA

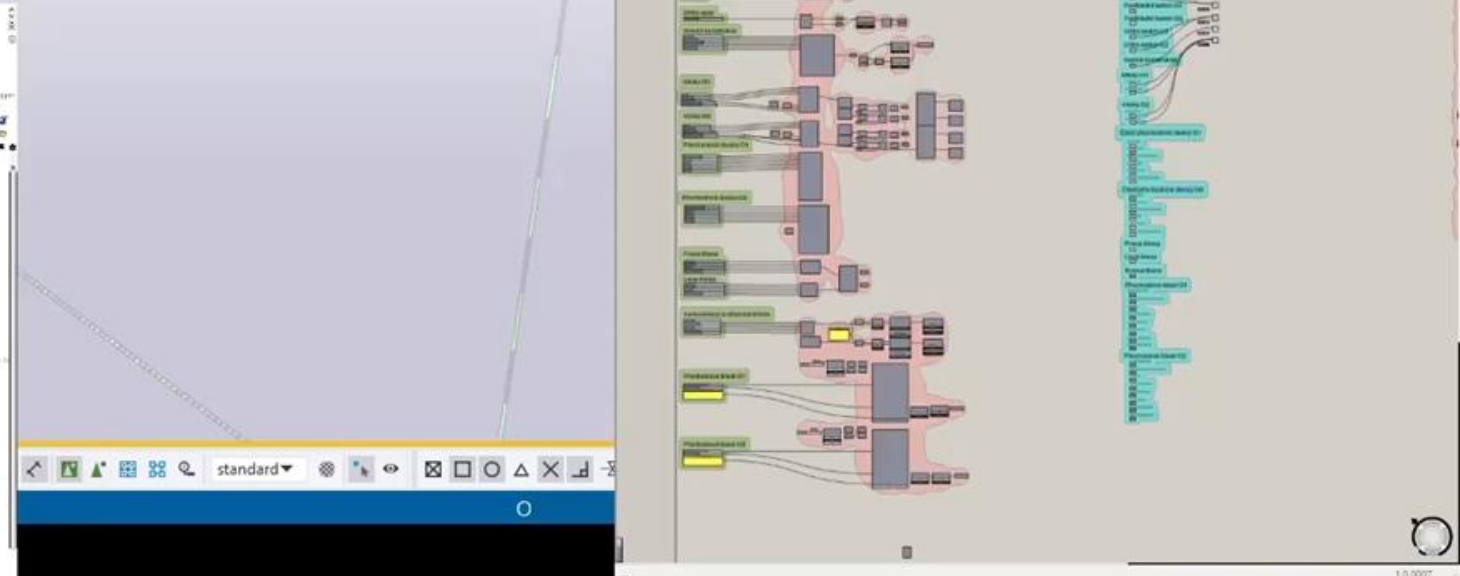
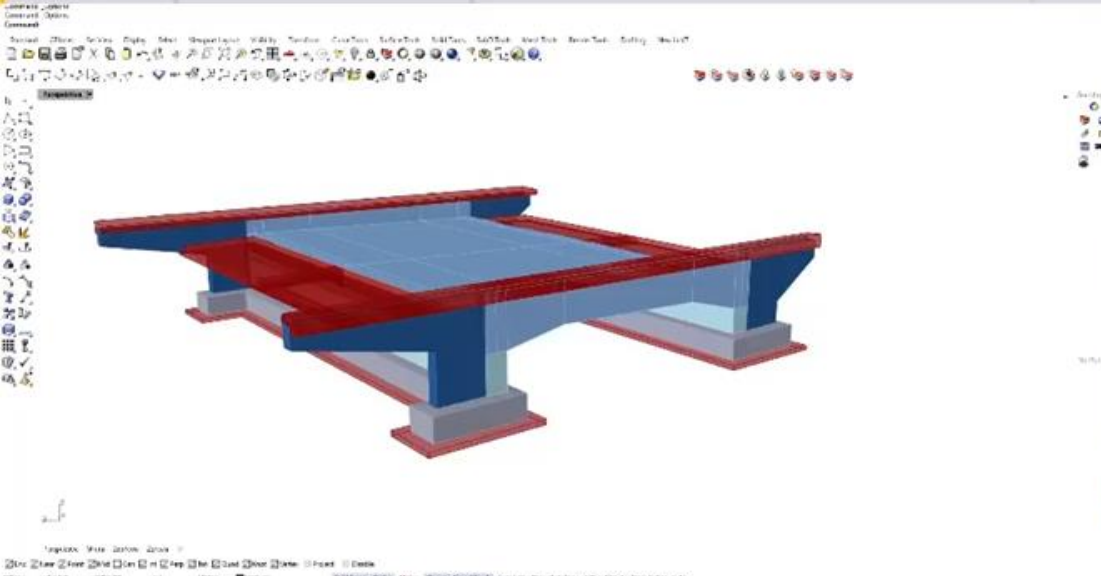
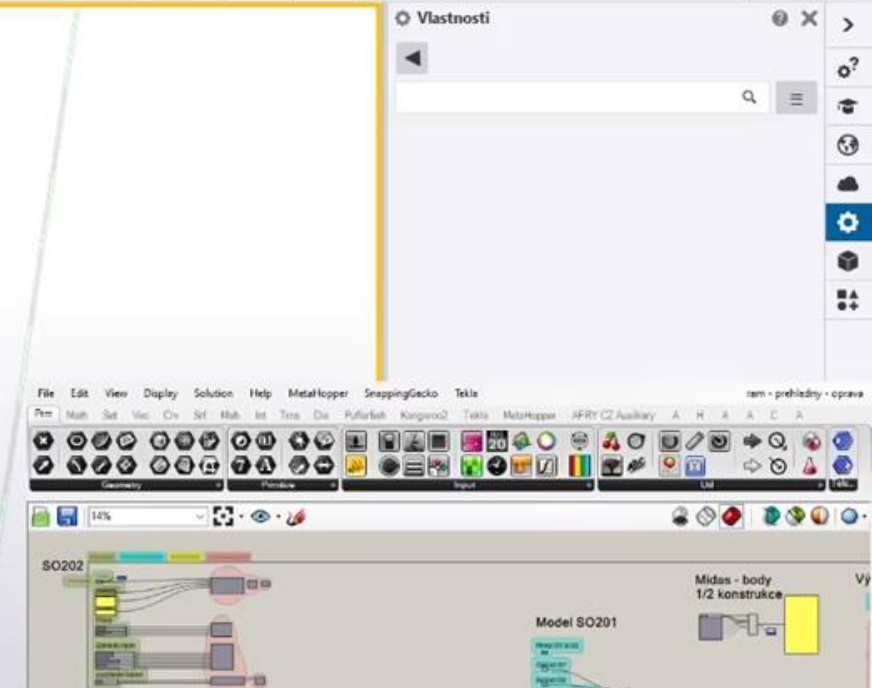
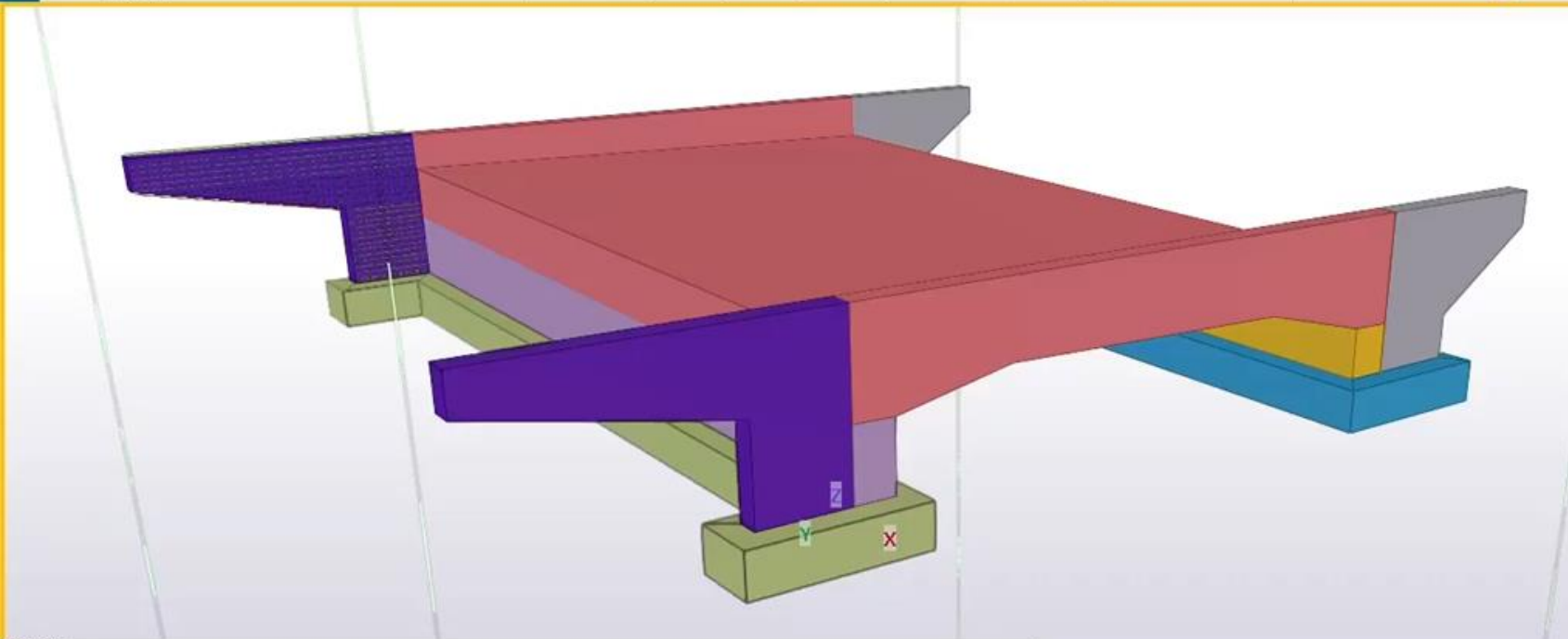
FINÁLNÍ GEOMETRIE/ OUTPUT GEOMETRY

0 100
1 150

- Blacktop thickness 0.135
- Left console width 1.7
- left slope parapet 6

Perspective

Top



Specific areas to be addressed

Bridges

❑ **Rhino +/-:**

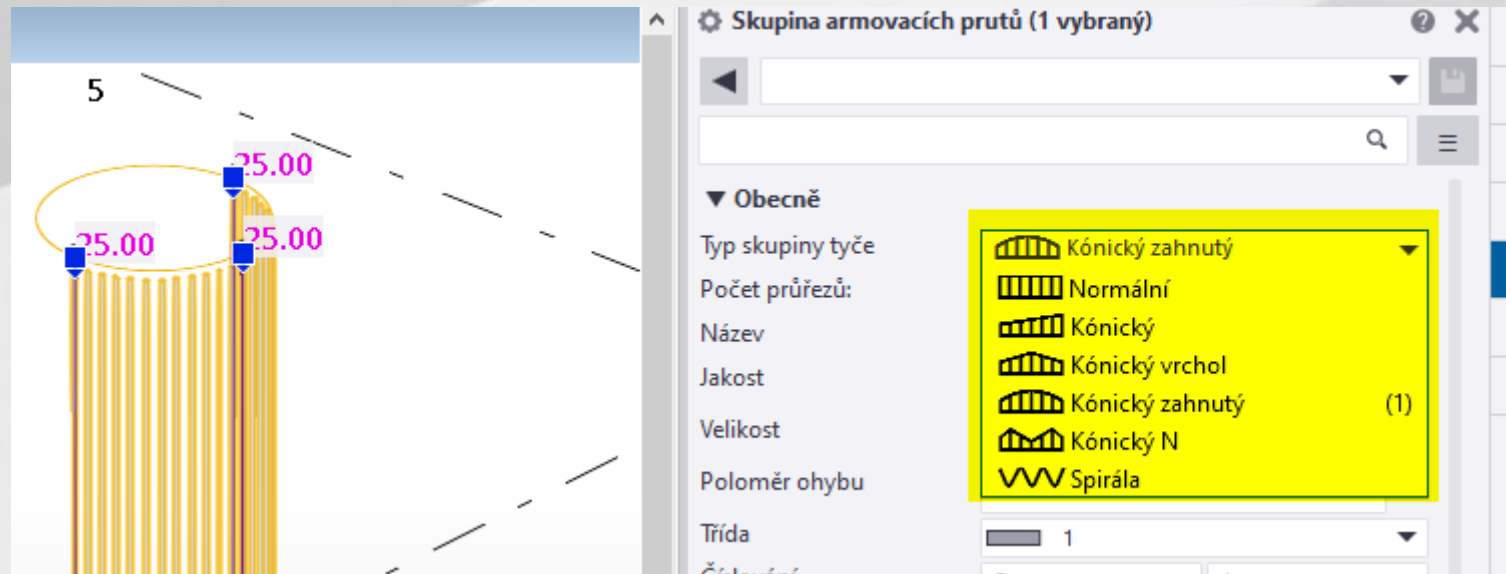
- + product knowledge
- + local support
- + price
- export to * .IFC

❑ **Tekla Structures+/-:**

- + product knowledge
- + local support
- + performance
- + export * .IFC (export to * .IFC 4.x could be better)
- + 3D reinforcement (reinforcement of more complex bridge deck shapes in circular, "curve" placement has several limitations, e.g., connections of longitudinal reinforcement)
- + OpenAPI
- limited modeling possibilities for concrete curved structures
- performance and support for drawings according to local standard, developed sections

Specific areas to be addressed

- ❑ limited modeling possibilities for concrete curved structures in Grasshopper-Tekla Live Link

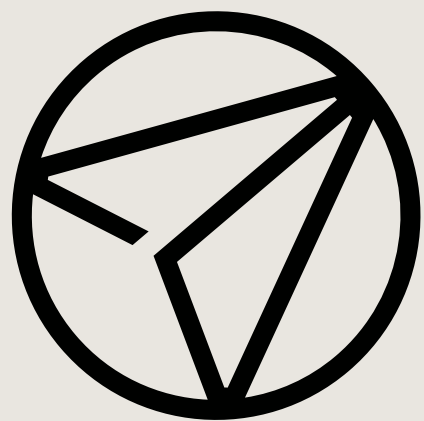


Motto

- ❑ **Cooperation based on expertise not SW**
- ❑ **OpenBIM workflow based on composing individual professional models in the open format * .IFC 4.x in CDE into a federated model. There is a way to prevent Vendor lock-in and at the same time allow individual professions to work for them in an optimal and effective SW solution**

Resources

- ❑ Mixed Reality https://www.linkedin.com/posts/pavel-vlas%C3%A1k-75b63552_trimblexr10-trimbleconnect-bim-activity-6865740899524083712-ivXY
- ❑ Parametric design of structures https://www.linkedin.com/posts/ond%C5%99ej-janota-67730111b_aec-vdc-rhino7-activity-6826552323880325120-Z-dR
- ❑ *.IFC <https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/>
- ❑ *.LandXML <http://www.landxml.org/>
- ❑ Data Standard of the State Fund for Transport Infrastructure of the Czech Republic (DS SFDI) <https://www.sfdi.cz/bim-informacni-modelovani-staveb/>



AFRY

ÅF PÖYRY