AUTODESK UNIVERSITY

Speed-up Railway Site Management: the Power of Automation and AEC Collection (CES501505)

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Agenda

About US
- FSTechnology S.p.a.
- The BIM and GIS Competence Center

Virtual construction site management
- Description
- Technical Instruction
  - Semi-automated calculation of cut&fill volumes
  - Estimate of the physical progress of the works

Conclusions
- Achieved benefits
- Next steps

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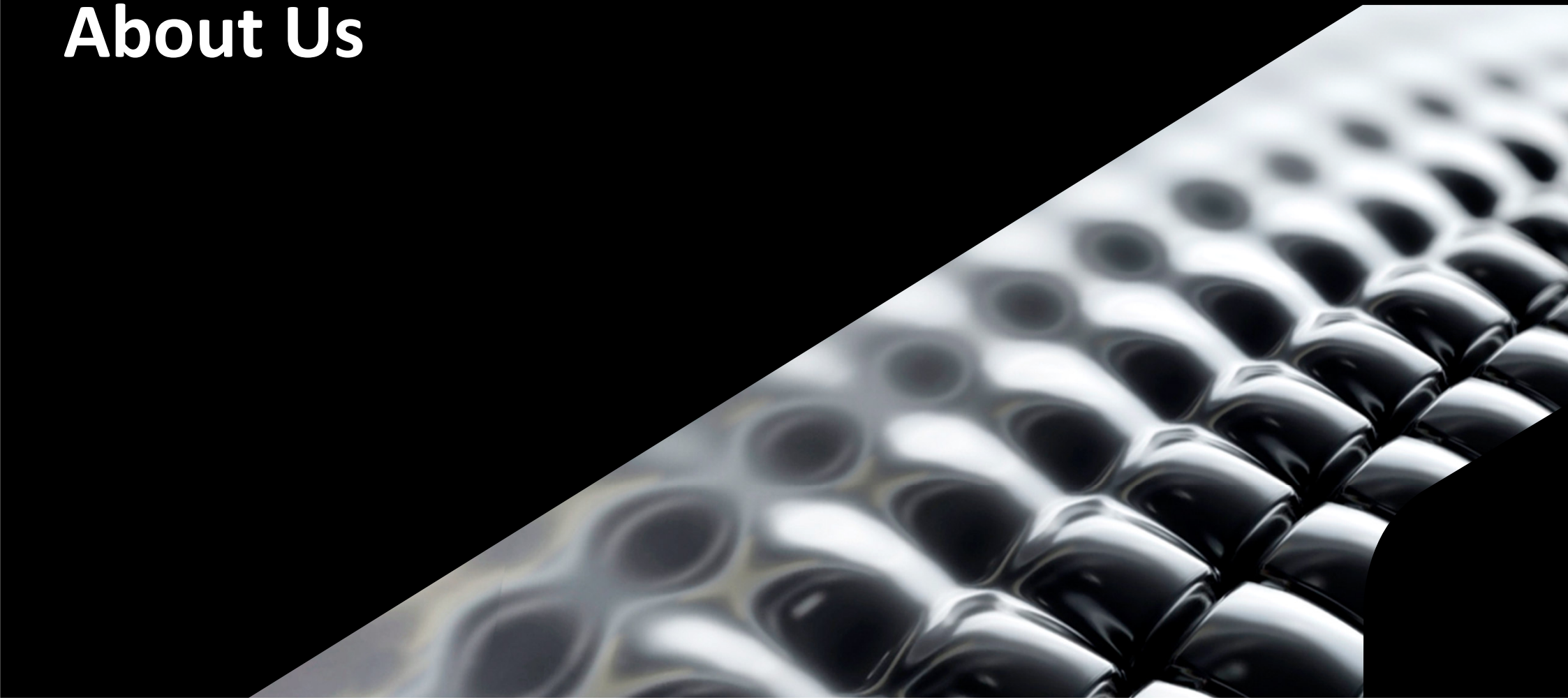
About Us



FSTechnology S.p.a.

FS Technology is the hi-tech company of the FS Italiane Group

The mission of FSTechnology is to strengthen and support digital innovation among all the group companies, and ensure top levels of quality, efficiency and time to market in customer services.

FSTechnology Spa

The BIM and GIS Competence Center

The BIM and GIS Competence Center is a team within FSTechnology.

The main objective of our team is to research and implement new technologies to improve the management of the processes and the workflows of the entire life cycle of infrastructure projects.

Considering the core processes of the group, we mainly support linear infrastructure projects, and therefore:

- **Italferr,** the engineering company of *Ferrovie dello Stato Italiane*
- **Rete Ferroviaria Italiana,** the company of *Ferrovie dello Stato Italiane* which owns of entire railway network

The BIM and GIS Competence Center

Marcella Faraone
Head of CC BIM&GIS

Alessandro Delle Monache
BIM GIS Technology Specialist

Ilaria Mascellani
GIS Specialist

Luca Capuani
GIS Specialist

Stefano Libianchi
BIM Expert

Eleonora Troiani
BIM Expert
Project Manager

Presentations, Publications and Awards

2018

400 Models, 9 Teams, One Coordination: BIM at Work

(CI226218) – AU LINK
Faraone M./Libianchi S.

Infrastructure FM: Effective Maintenance of Railways and Roads Using BIM and GIS

(CI226373) – AU LINK
Faraone M./Quadrini P.

Advantages of GIS & BIM Integration throughout the Entire Building Lifecycle

Esri: European Transportation GIS Summit LINK
Faraone M.

2019

Maintenance of 630 stations: from underground utilities survey to Civil3D and GIS

(CI322485) – AU LINK
Faraone M./Libianchi S.

ESRI: 2019 SAG Award Winners

LINK
Faraone M.

BIM: Actual

LINK
Faraone M.

2020

Virtual Construction-Site Management with Advanced Workflow in BIM 360

(CS468465) – AU LINK
Ferro R./Libianchi S.

2021

Construction site management with advanced workflow in Construction Cloud

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Virtual Construction/Site Supervision with the ESri and Autodesk Platforms

North American GIS Rail Summit LINK
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2022

A BIM/GIS Workflow Benefits Key Railway Construction Project in Italy

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Drones, digital twins and AI: inside Ferrovie dello Stato's ground-breaking

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Virtual construction site management

Virtual construction site management

TEN-T: Trans-European Transport Network

The Trans-European Transport Network (TEN-T) policy addresses the implementation and development of a Europe-wide network of railway lines, roads, inland waterways, maritime shipping routes, ports, airports and railroad terminals. The ultimate objective is to close gaps, remove bottlenecks and technical barriers, as well as to strengthen social, economic and territorial cohesion in the EU.

TEN-T comprises two network ‘layers’:

- The Core Network that includes the most important connections, linking the most important nodes, and is to be completed by 2030
- The Comprehensive Network that covers all European regions and is to be completed by 2050.

https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

Virtual construction site management

Support Construction Site Managers

Construction health and safety checks

Work in Progress and Quality checks

Environmental inspections during construction

Virtual construction site management

The Technologies Used

Drone Surveys

- Ortophoto or Ortomosaic
- Point Clouds Models
- BubbleViews

BIM-GIS Integration

- Cut and Fill volumes calculation
- Construction site progress

Data Analytics

- Artificial Intelligence
- Augmented Reality
- Virtual Reality
- Environmental Control

Virtual construction site management

Data Post Processing

Artificial Intelligence

- Automated Analysis of images
- Specific item identifications
- Time reduction
- Illegal landfills
- Dangerous chemicals leakage
- Environmental contamination

AR – VR

- Integration Bim Models & Gis Data
- Easy Navigation (WASD or Mouse&Arrows Keys)
- Easy Sharing
- Immersive Experience

Environmental Control

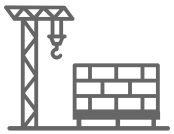
- Post operam analysis
- Assets protection
- Dangerous chemicals leakage
- Environmental contamination

Virtual construction site management

Two needs - Two workflows

Semi-automated calculation of cut&fill volumes

- Point clouds from drone surveys
- Cut-out and DEMs from site areas
- Volumetric surfaces for comparison in Civil 3D
- Output reports for further analysis



Estimate of the physical progress of the works

- Automated production of a Revit model
- Automated parameter population
- Clash detection in NavisWorks
- Algorithm to calculate the progress and integration within the project dashboard

Workflow analysis
Requirements and solutions implemented

- Requirements:
  - Set up a workflow with a few clicks and checks
  - Reduce processing times
  - Get manageable drawings/outputs, that can be reused on other processes
  - Preserve a good accuracy

- Technical Solutions:
  - Point cloud decimation
  - DEMs elaboration
  - Automation through scripts
  - Use of calculation algorithms

Workflow analysis
Required formats

For the post processing of the images and the scans acquired on site by our surveyors, we request different formats for different purposes:

- **Ortophotos**

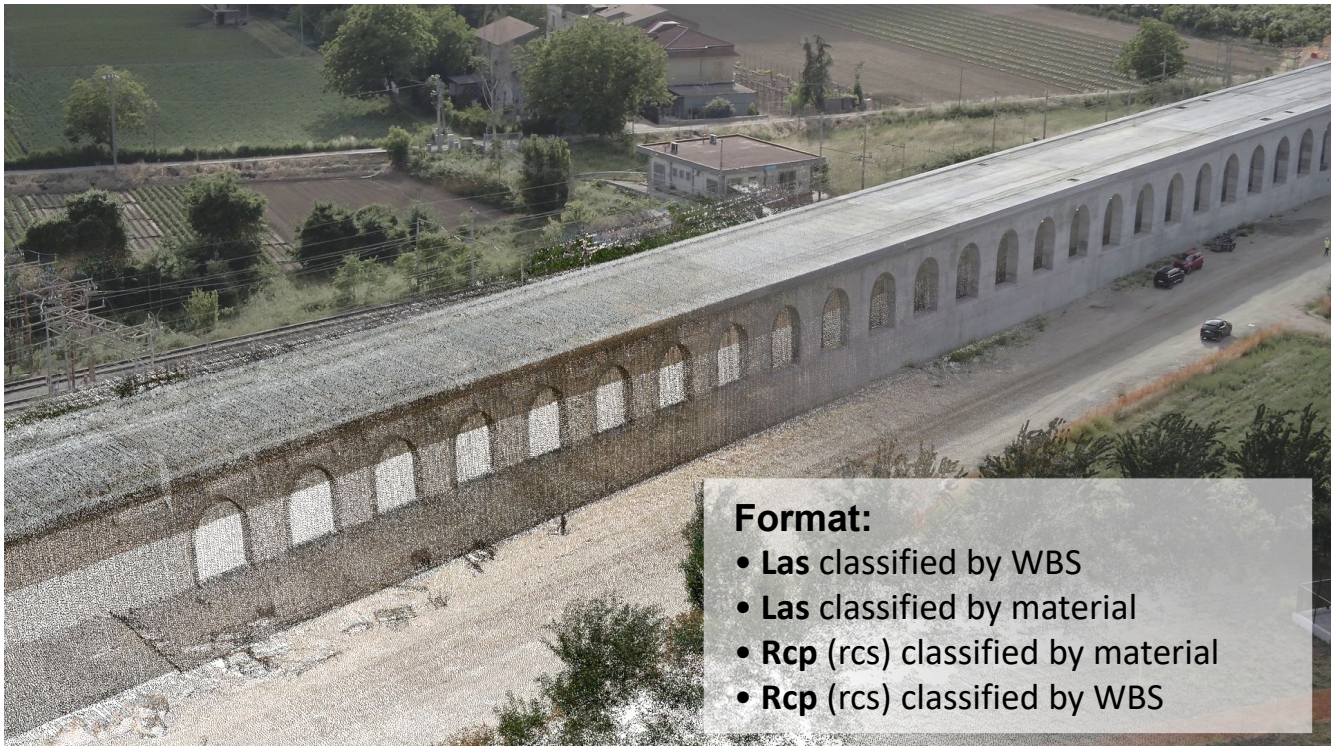
Technical data

- 45Mpx and102 Mpx cameras
- Ortophoto resolutiion >= 2cm/pixel
- Image acquisition rate: 1 photo / 2 seconds

Workflow analysis
Required formats

For the post processing of the images and the scans acquired on site by our surveyors, we request different formats for different purposes:

- Ortophotos
- **3D Point Cloud Models**



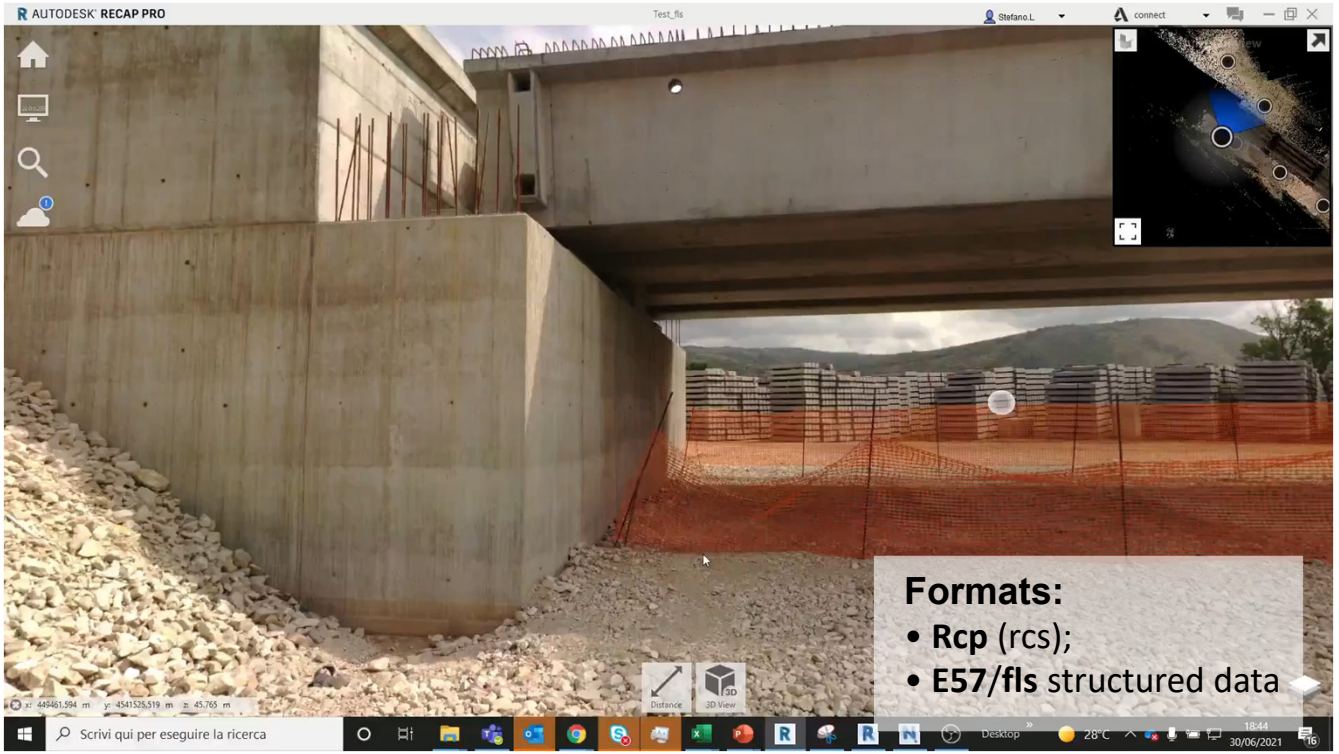
Technical data

- Accuracy ≤ 15mm
- Precision ≤ 10mm

Workflow analysis
Required formats

For the post processing of the images and the scans acquired on site by our surveyors, we request different formats for different purposes:

- Ortophotos
- 3D Point Cloud Models
- **360° Photos for the Bubbleviews**

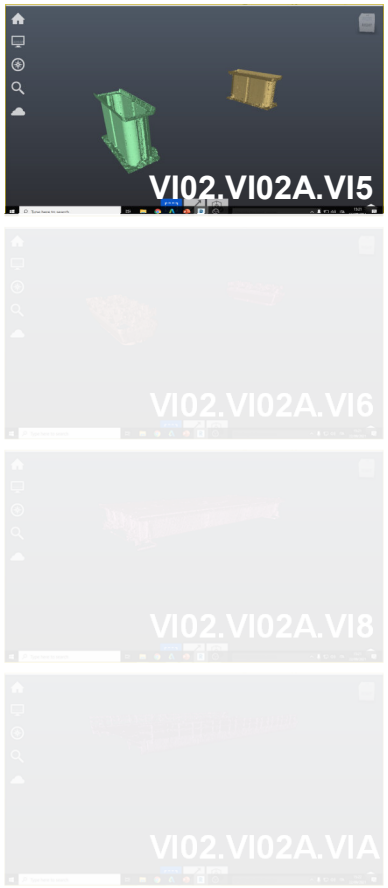


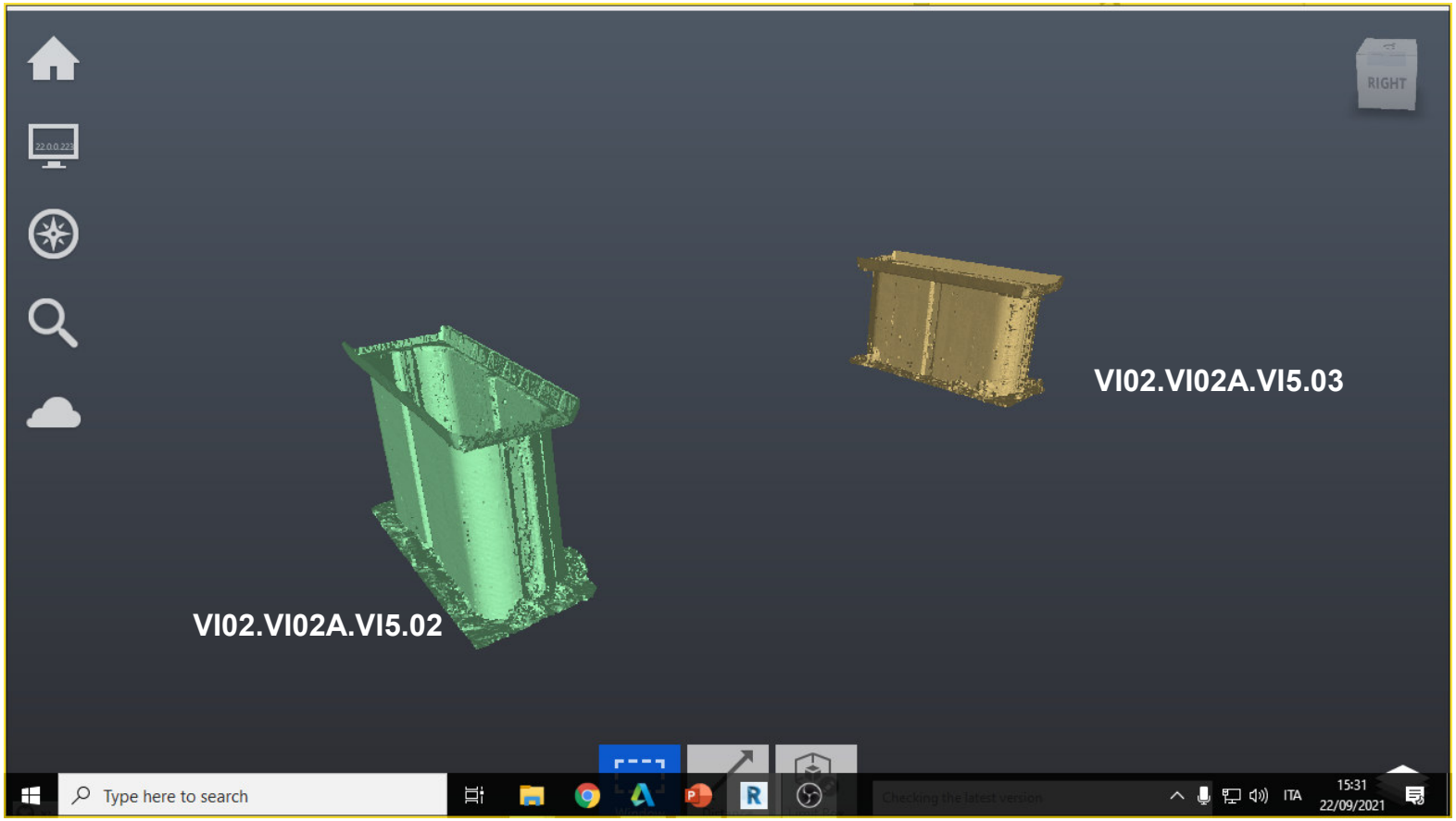
Technical data

- Point acquisition rate: 2 million/s
- Range: 70 metri
- Precision ≤ 1.9mm at 10m

Workflow analysis

Required formats – Classification by WBS





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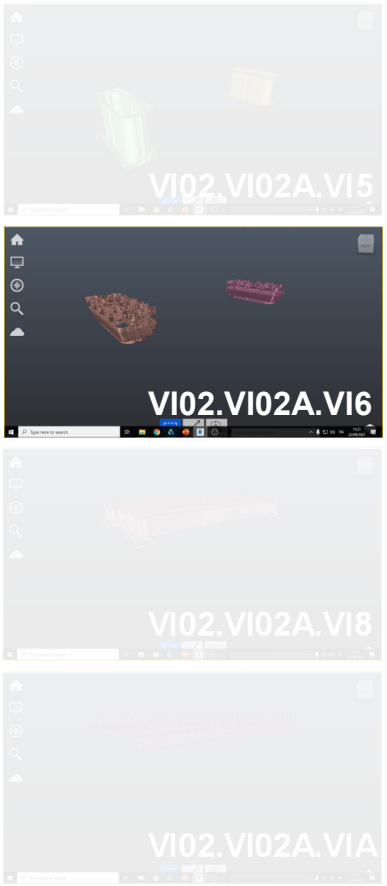

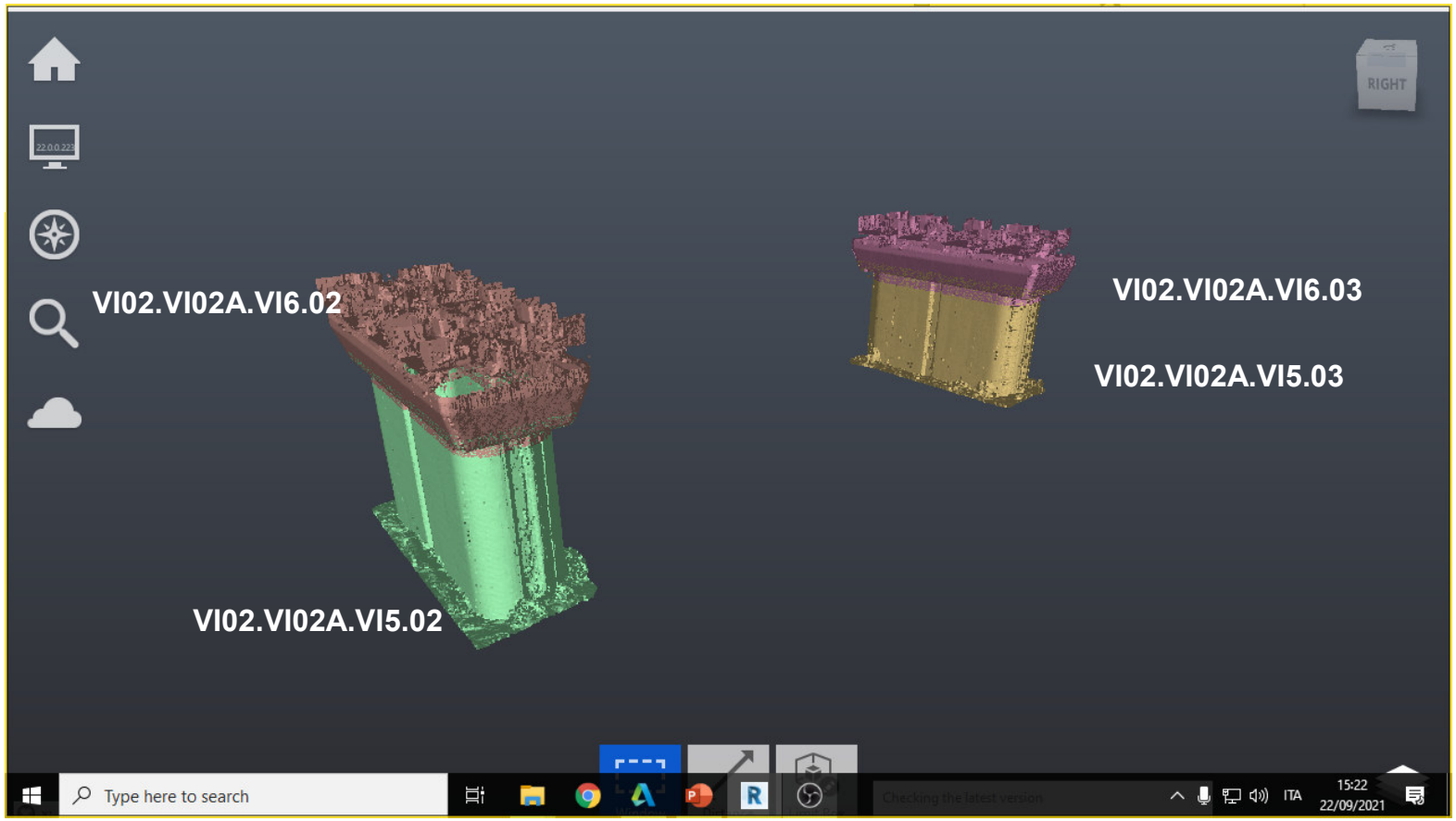

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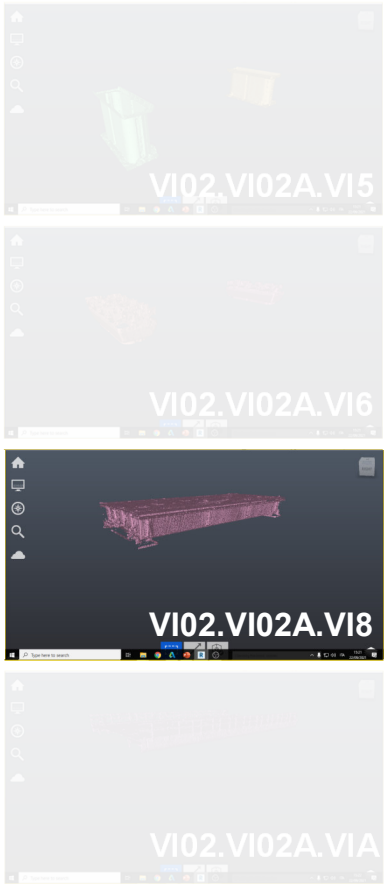

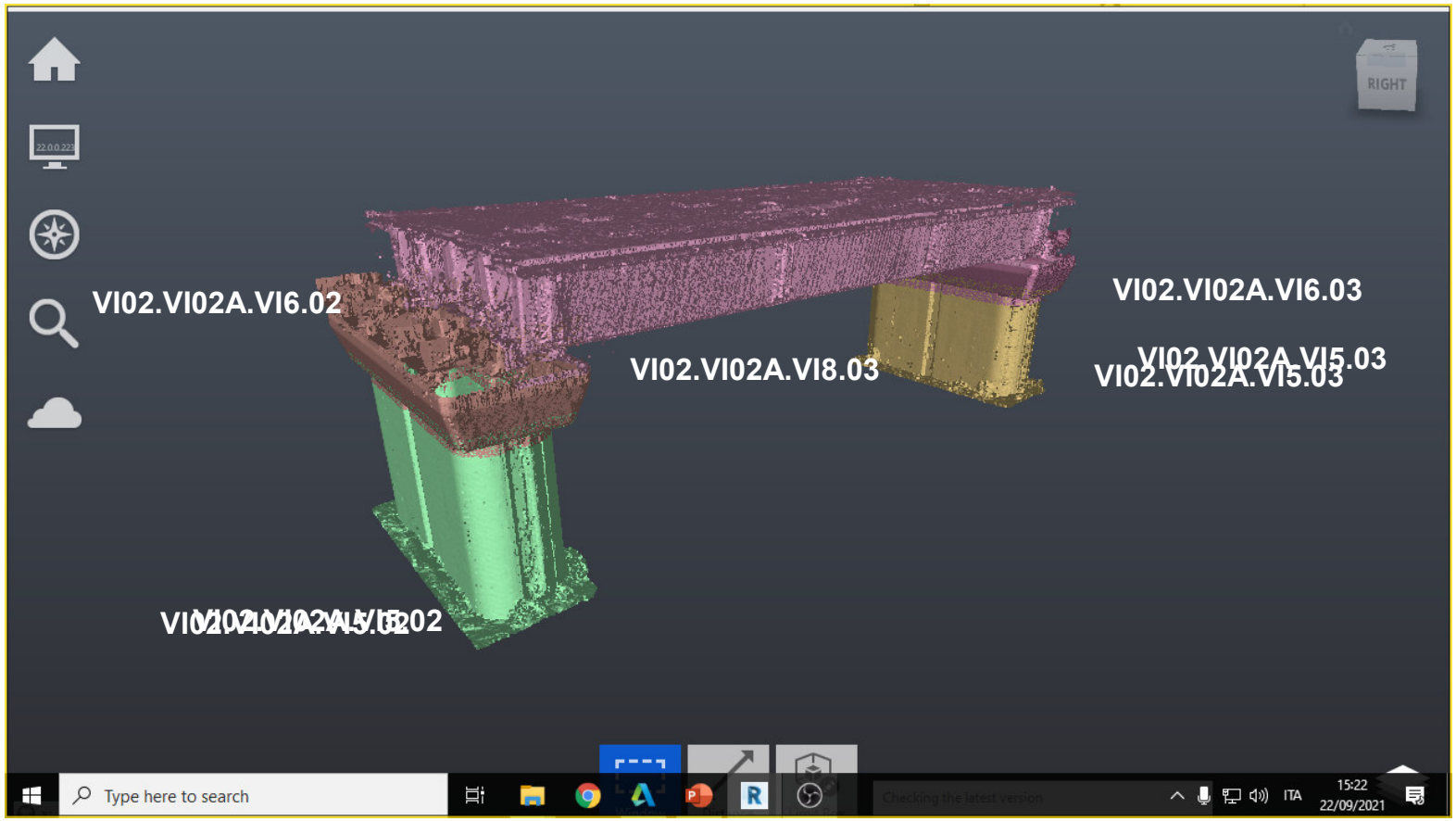

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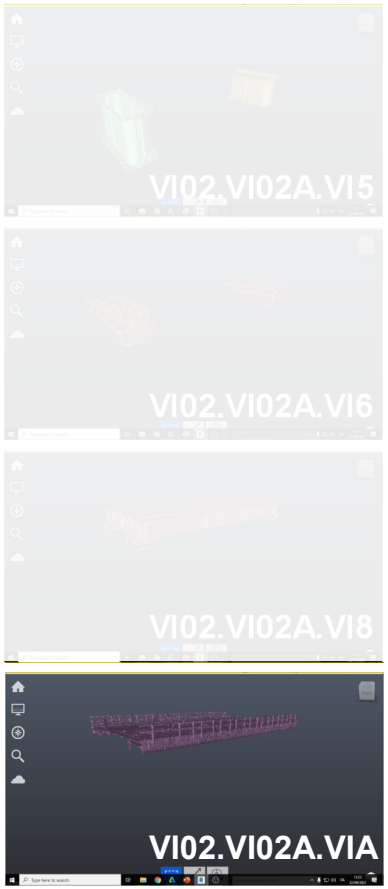
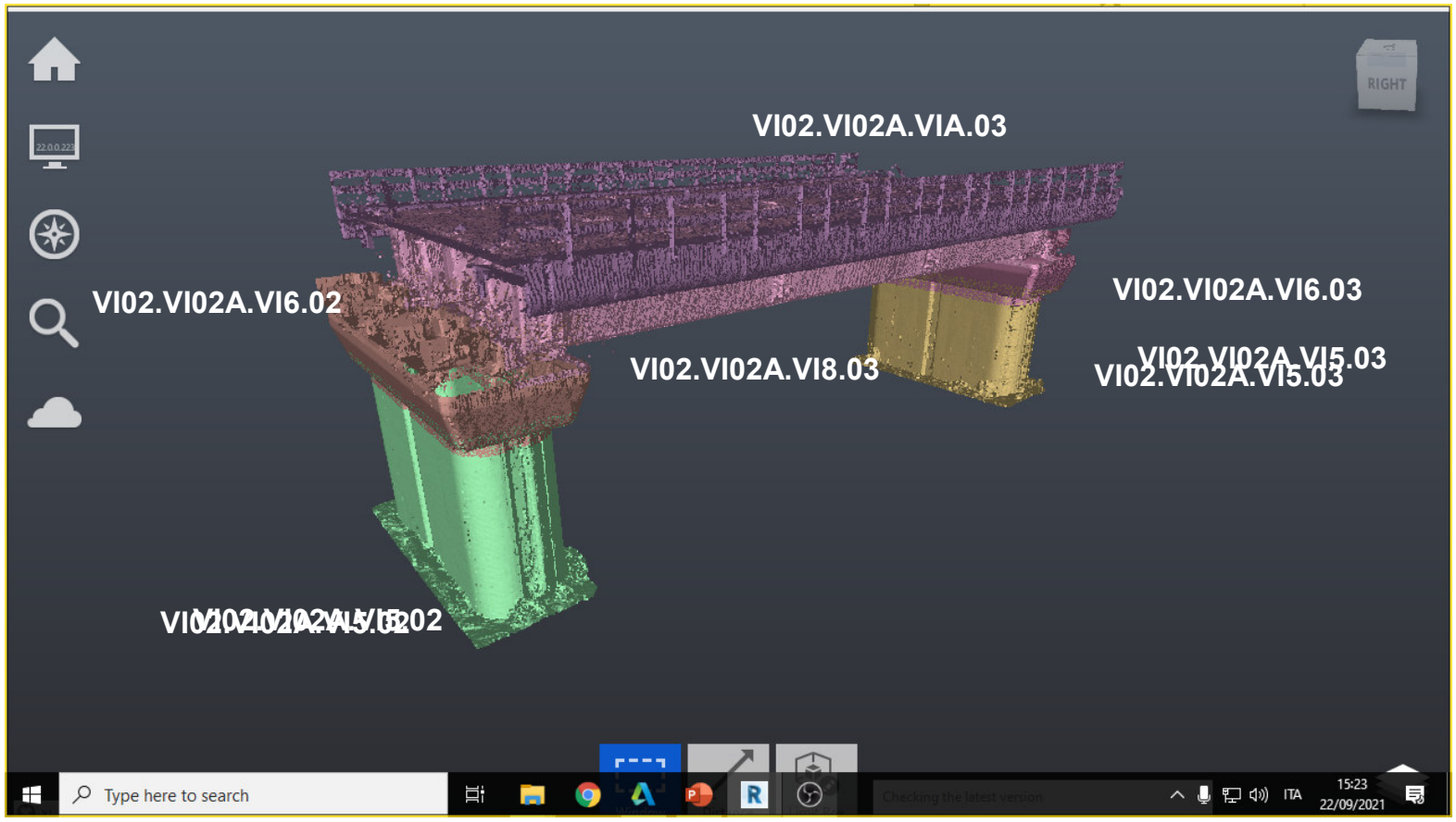
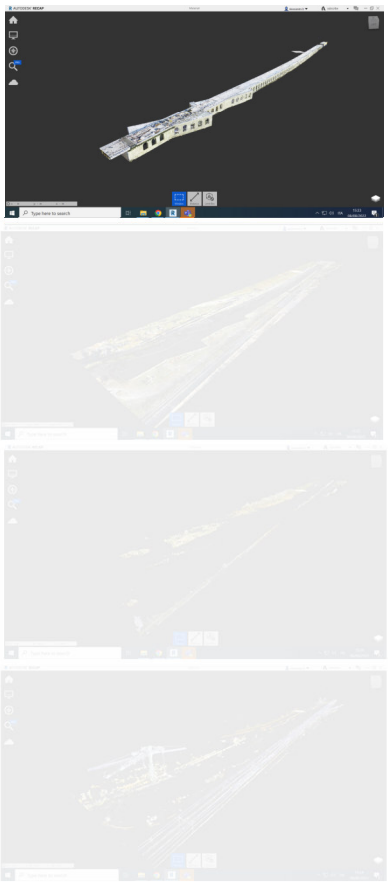
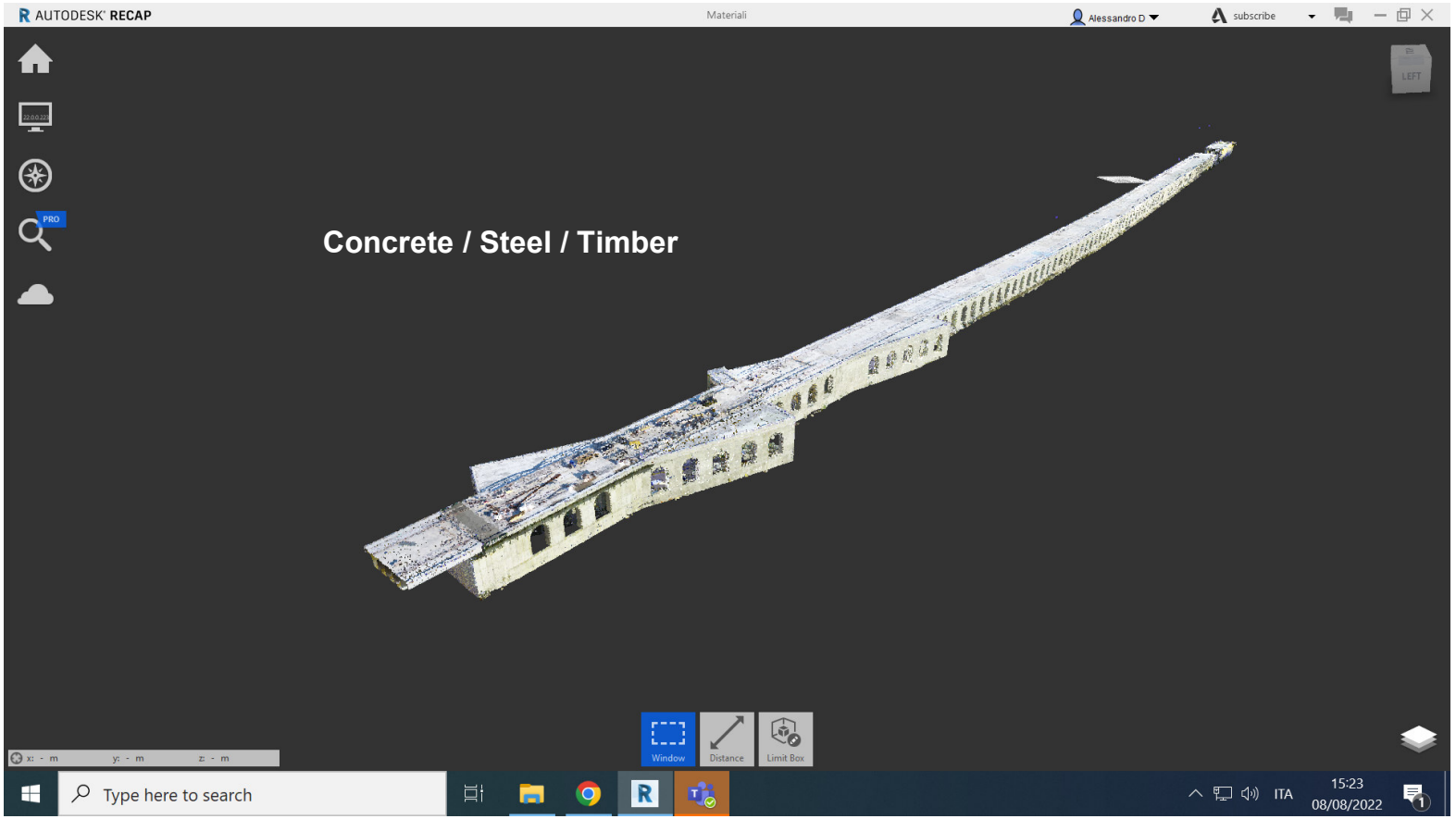




Workflow analysis

Required formats – Classification by material





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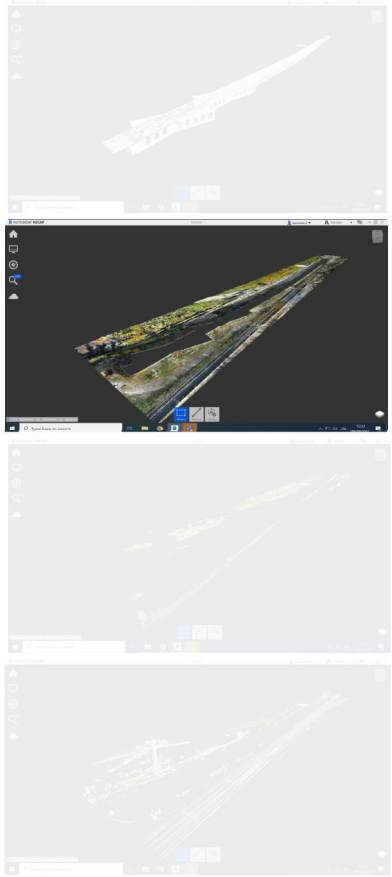

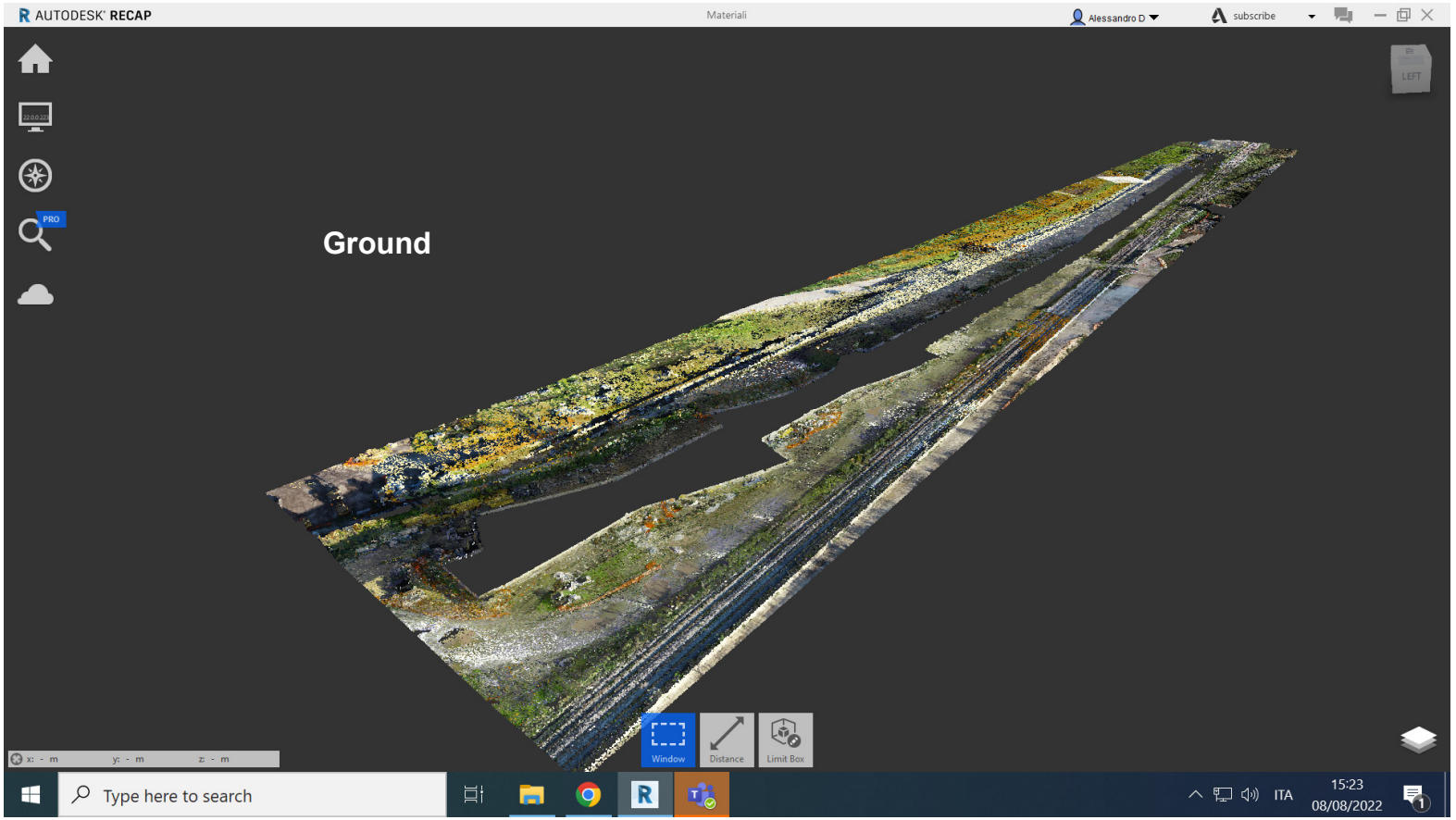

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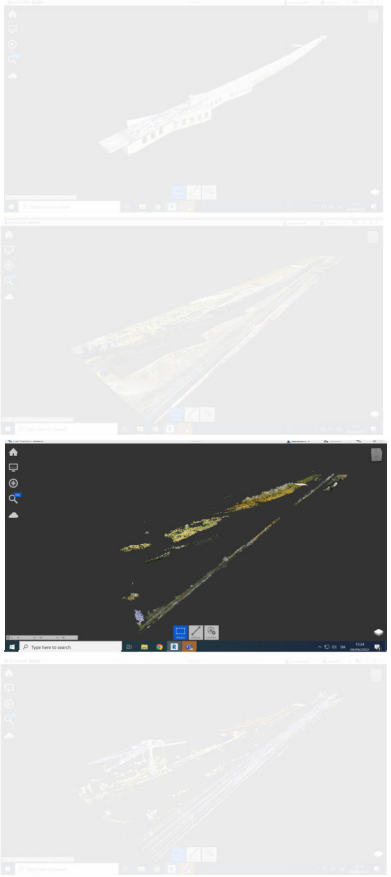

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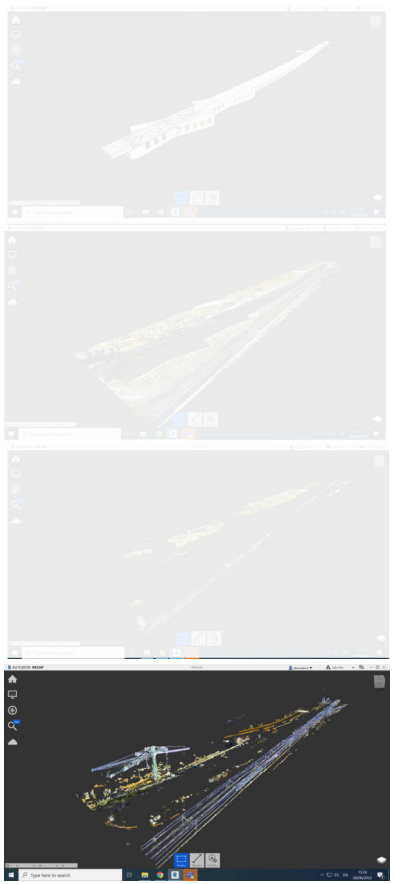

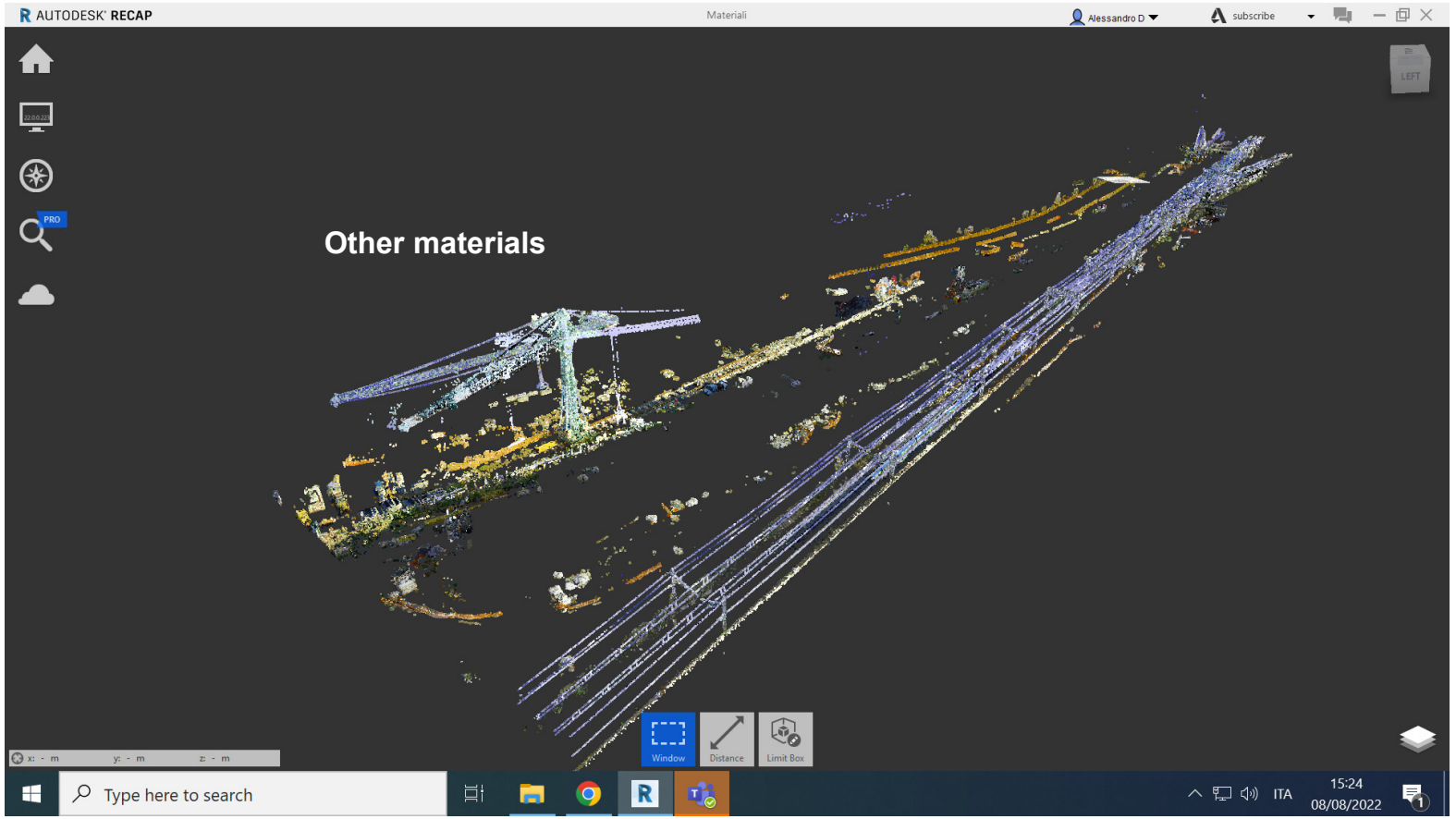

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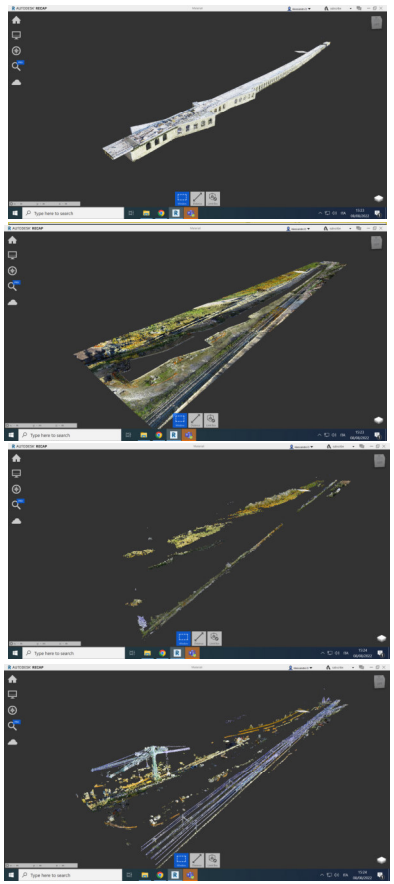
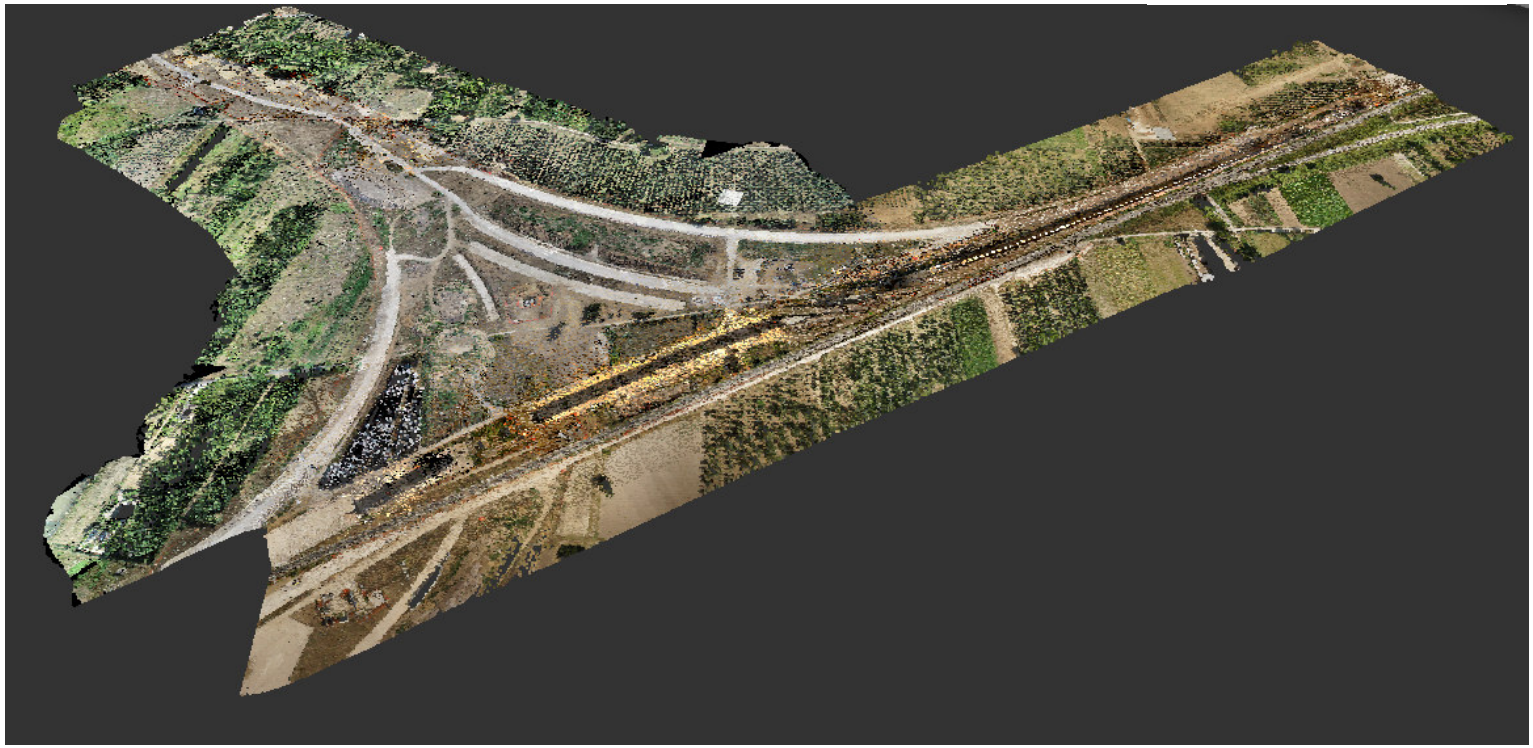


Workflow analysis

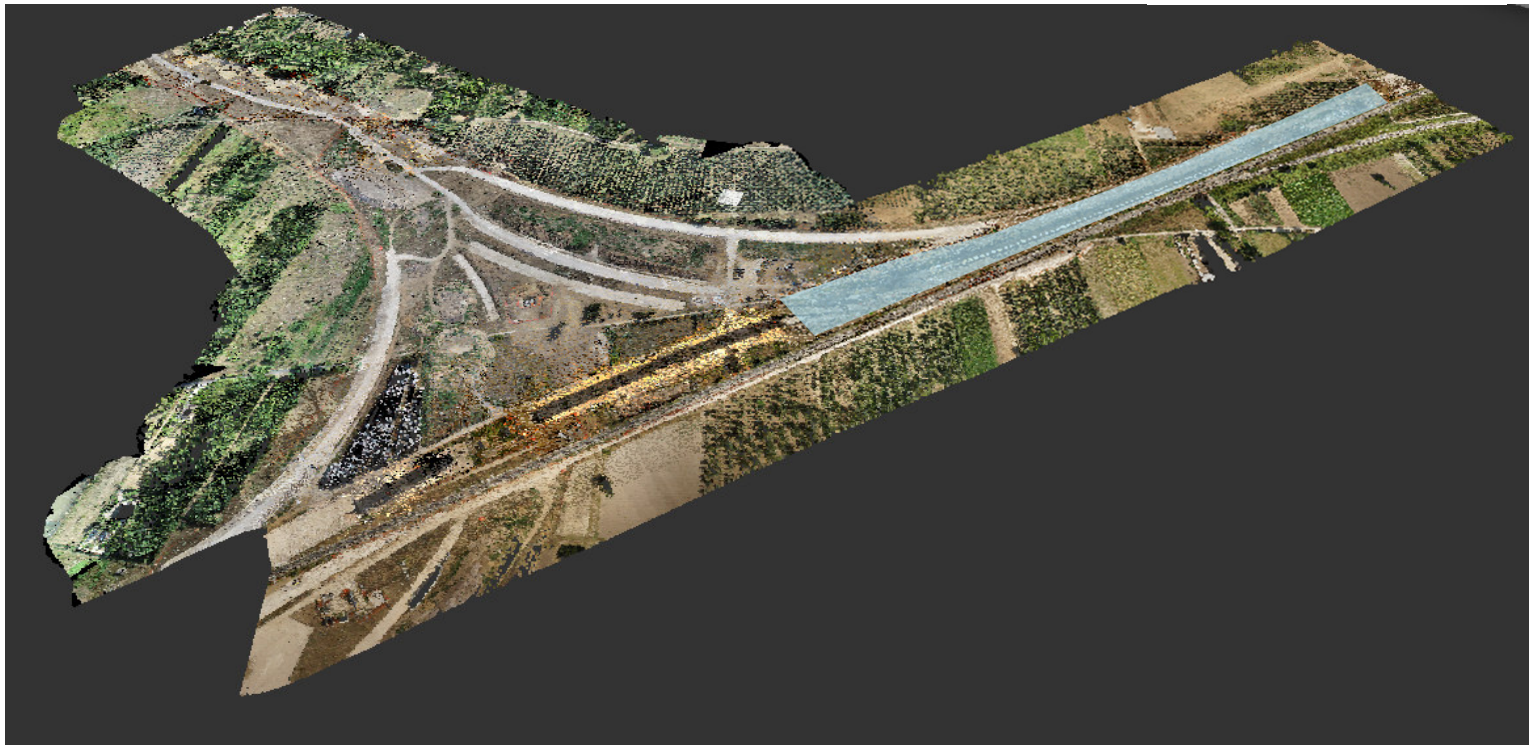
Construction site areas

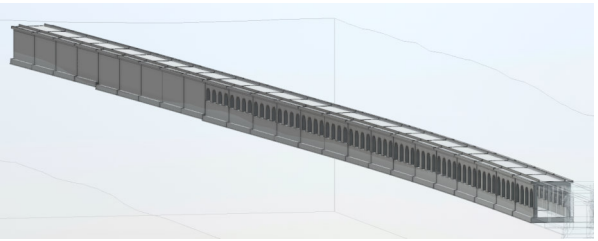


Workflow analysis

Construction site areas

VI01

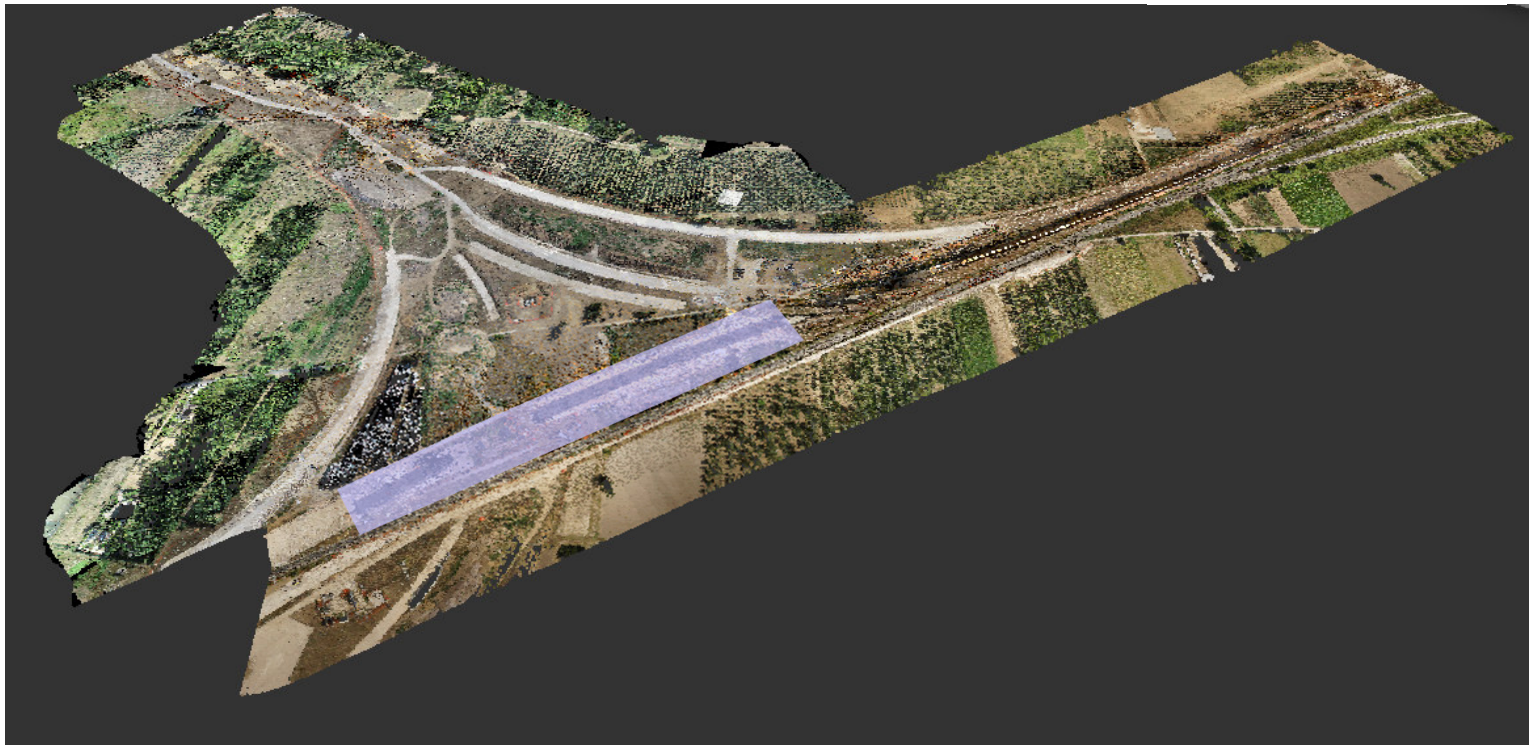


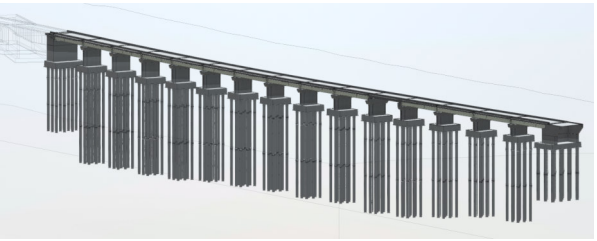


Workflow analysis

Construction site areas

- VI01
- VI02

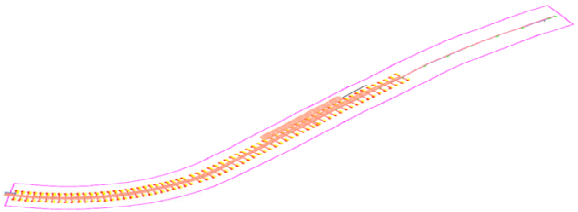


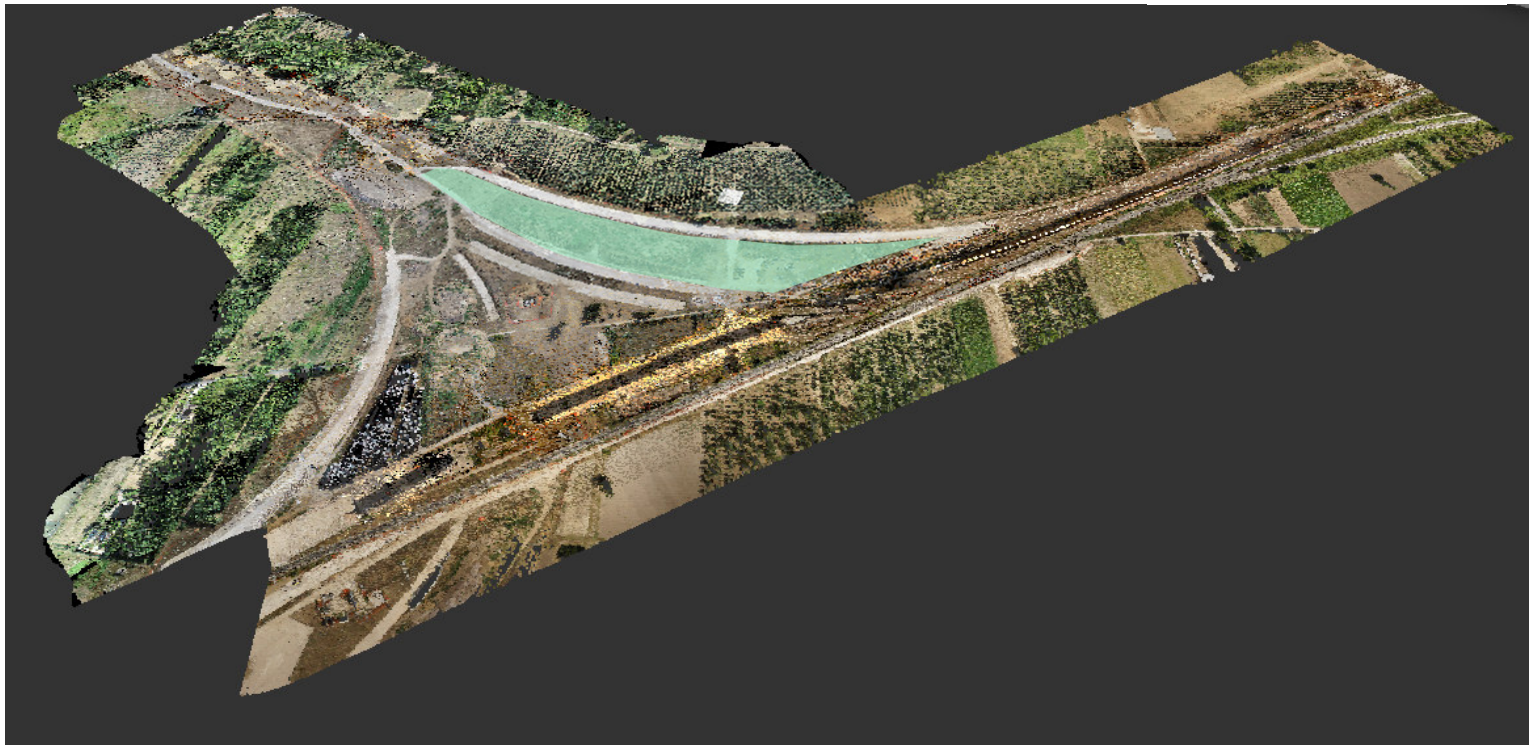


Workflow analysis

Construction site areas

- VI01
- VI02
- RI01





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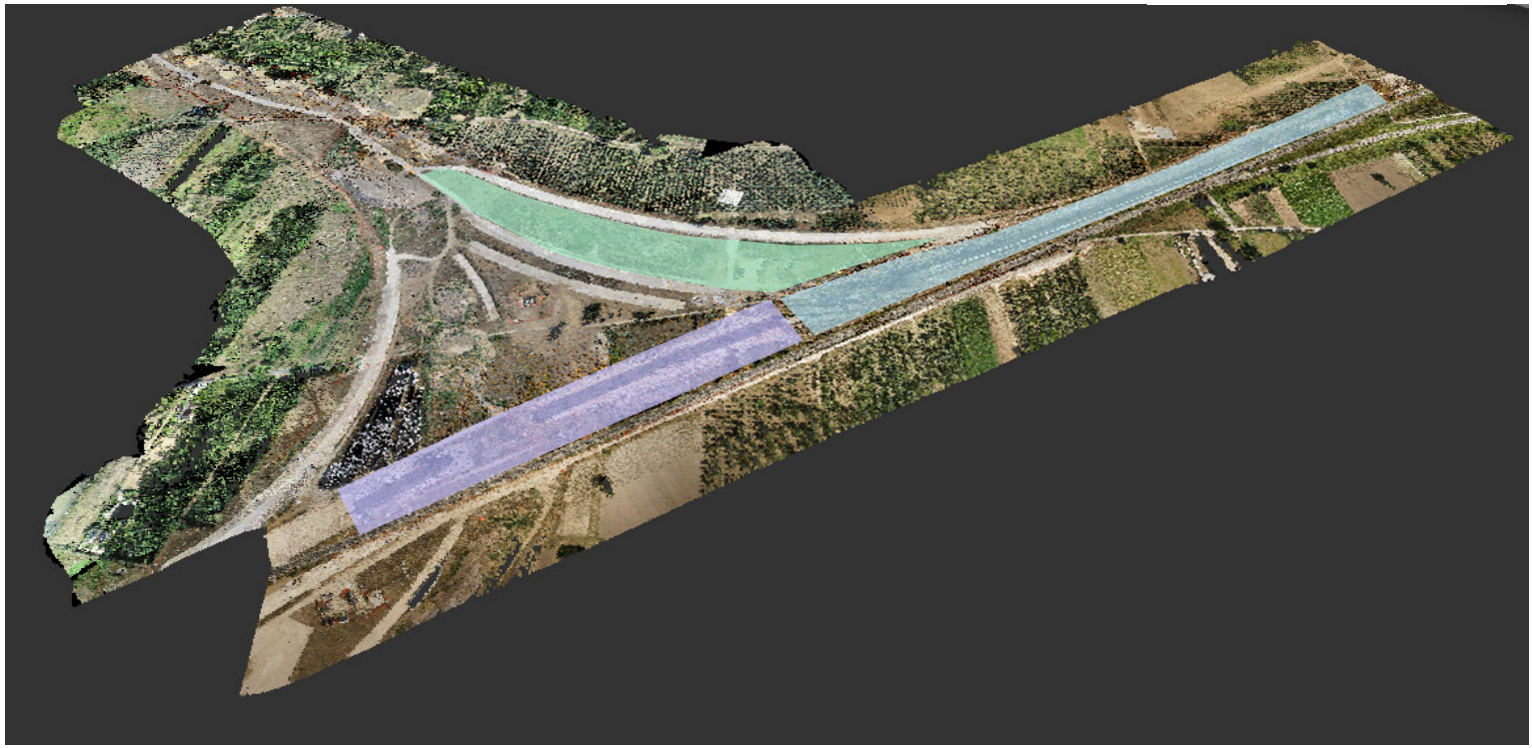
Construction site areas

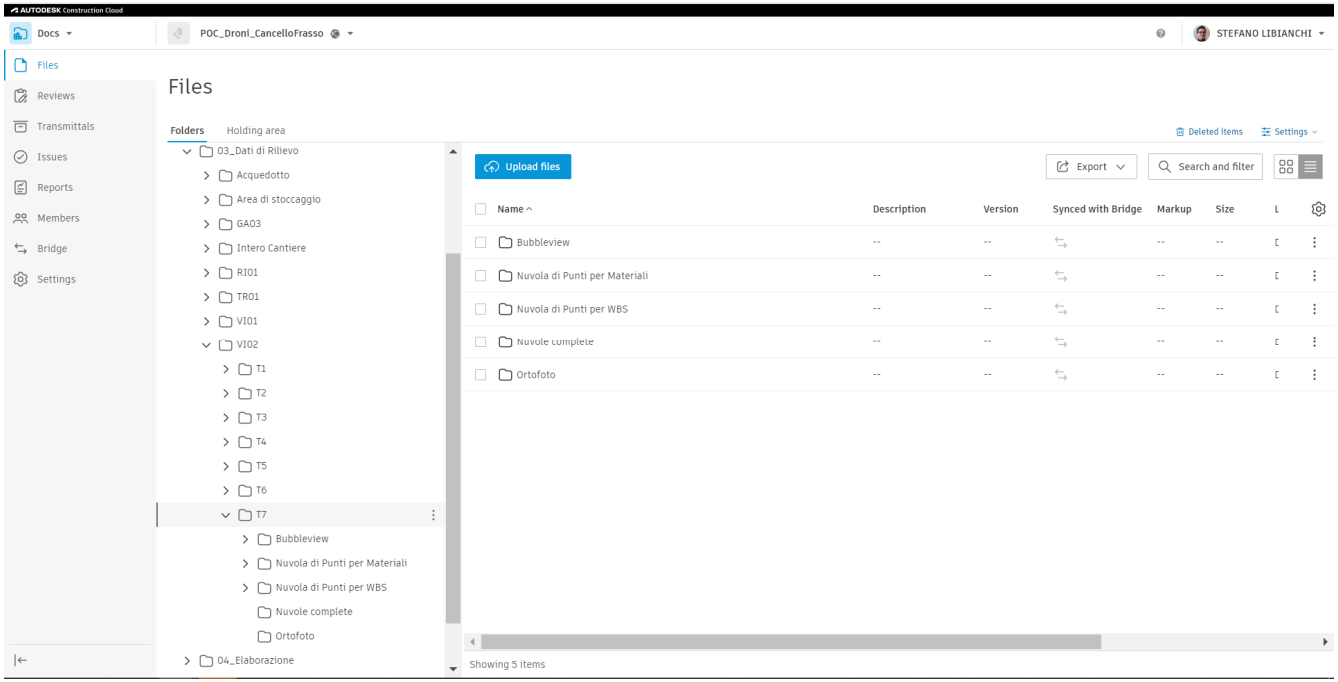
- VI01
- VI02
- RI01



Workflow analysis
Folder structure on ACC

ACC folder structure:

- **Main WBS Element**
  - **Survey**
    - **Bubbleview**
    - **Point Clouds by Material**
    - **Point Clouds by WBS**
    - **Structured Point Clouds**
    - **Ortophotos**



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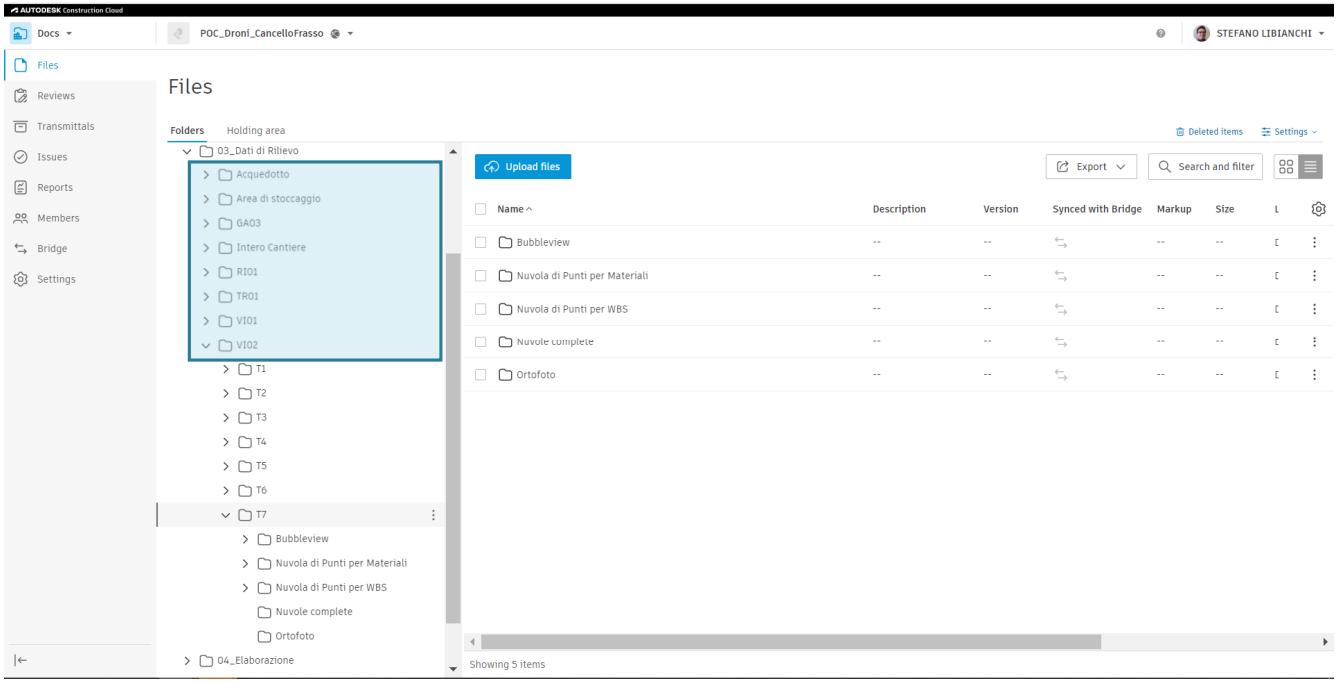

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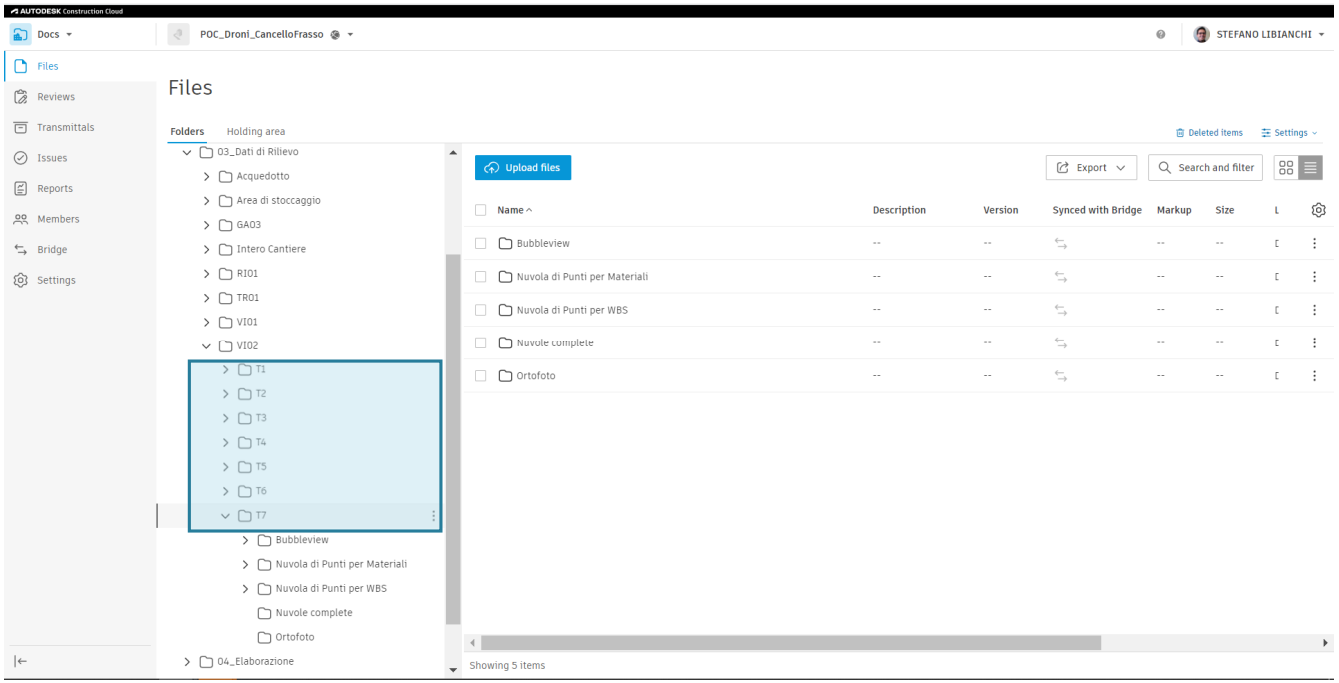

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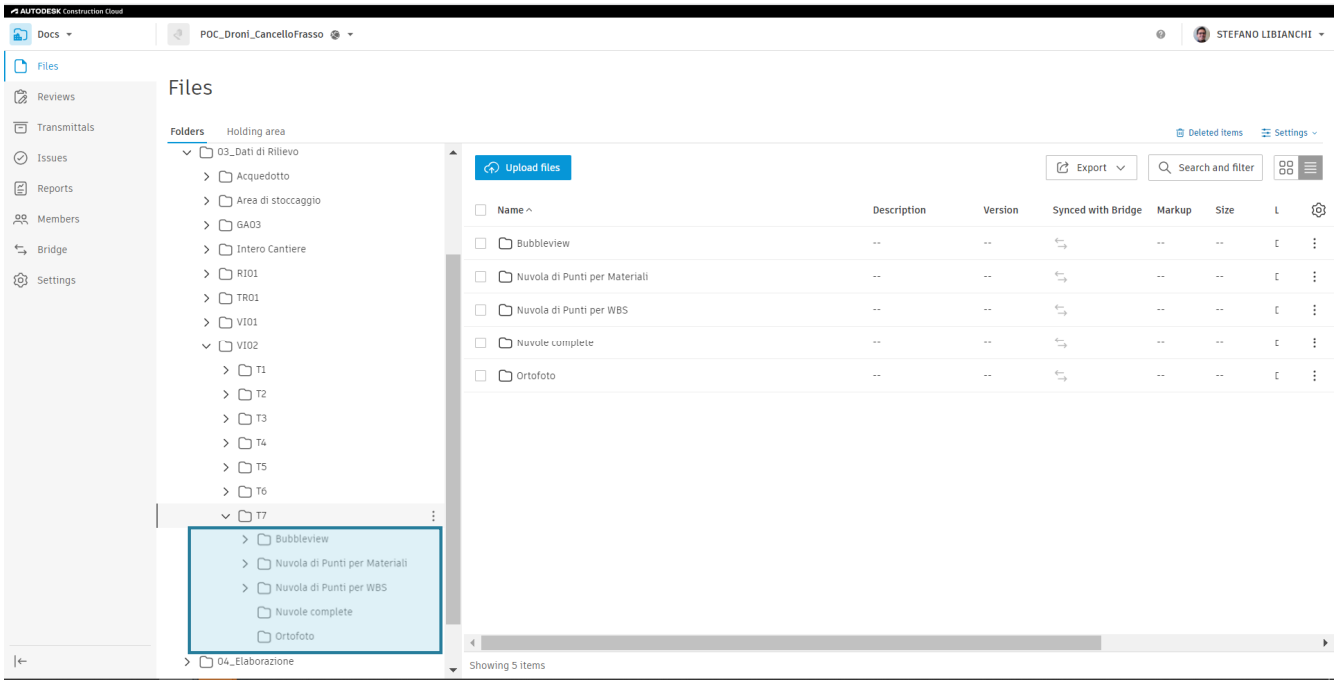


Workflow analysis
Surveys

2019 2020 2021 2022

- VI01
- VI02
- RI01

Partners

AUTODESK

Simone Cappochin

Santi Sarica

Paolo Quadrini

ENGINEERING

Raffaele Ausiello

Mauro Balcerini

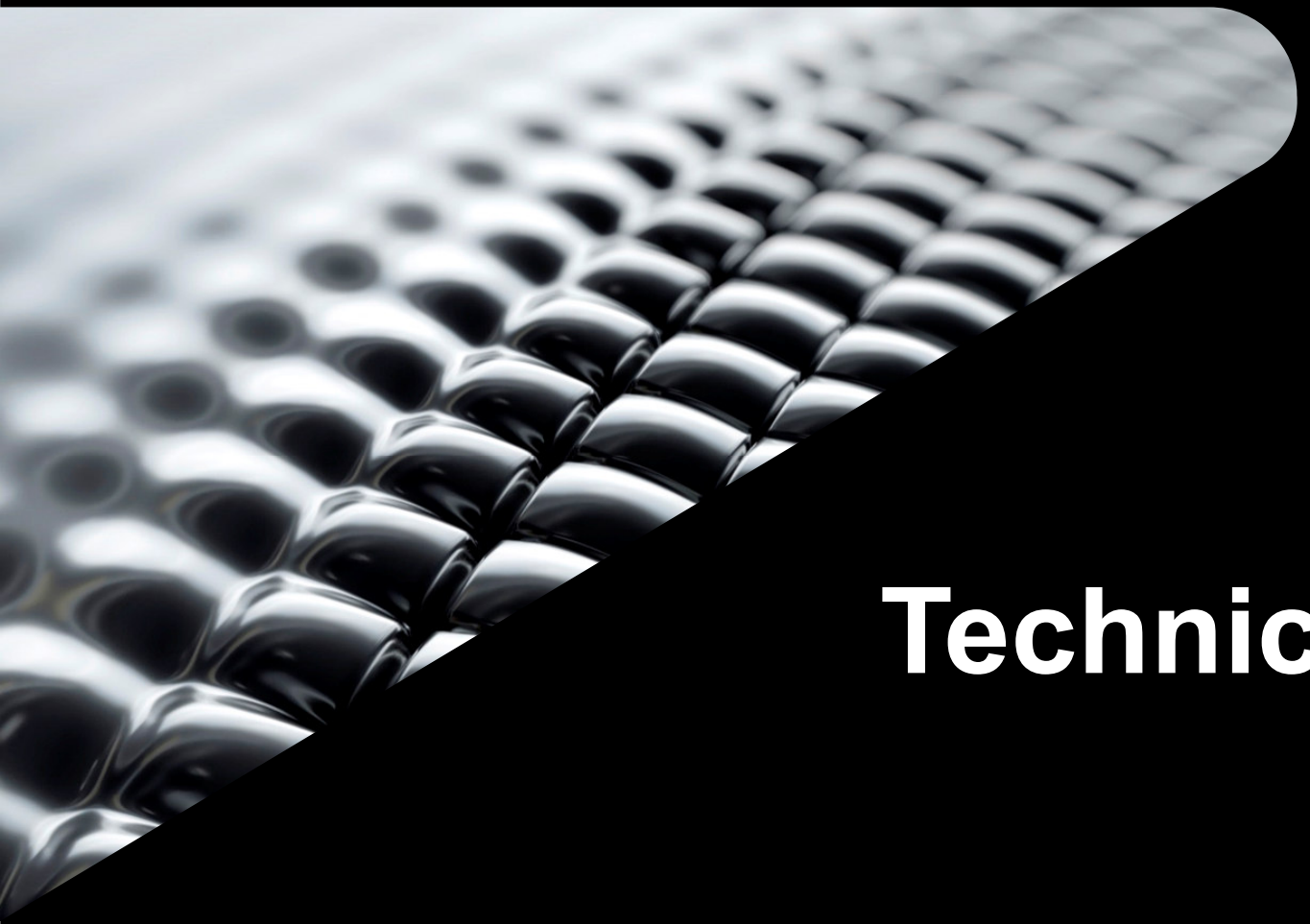
Microsoft

SEiKEY

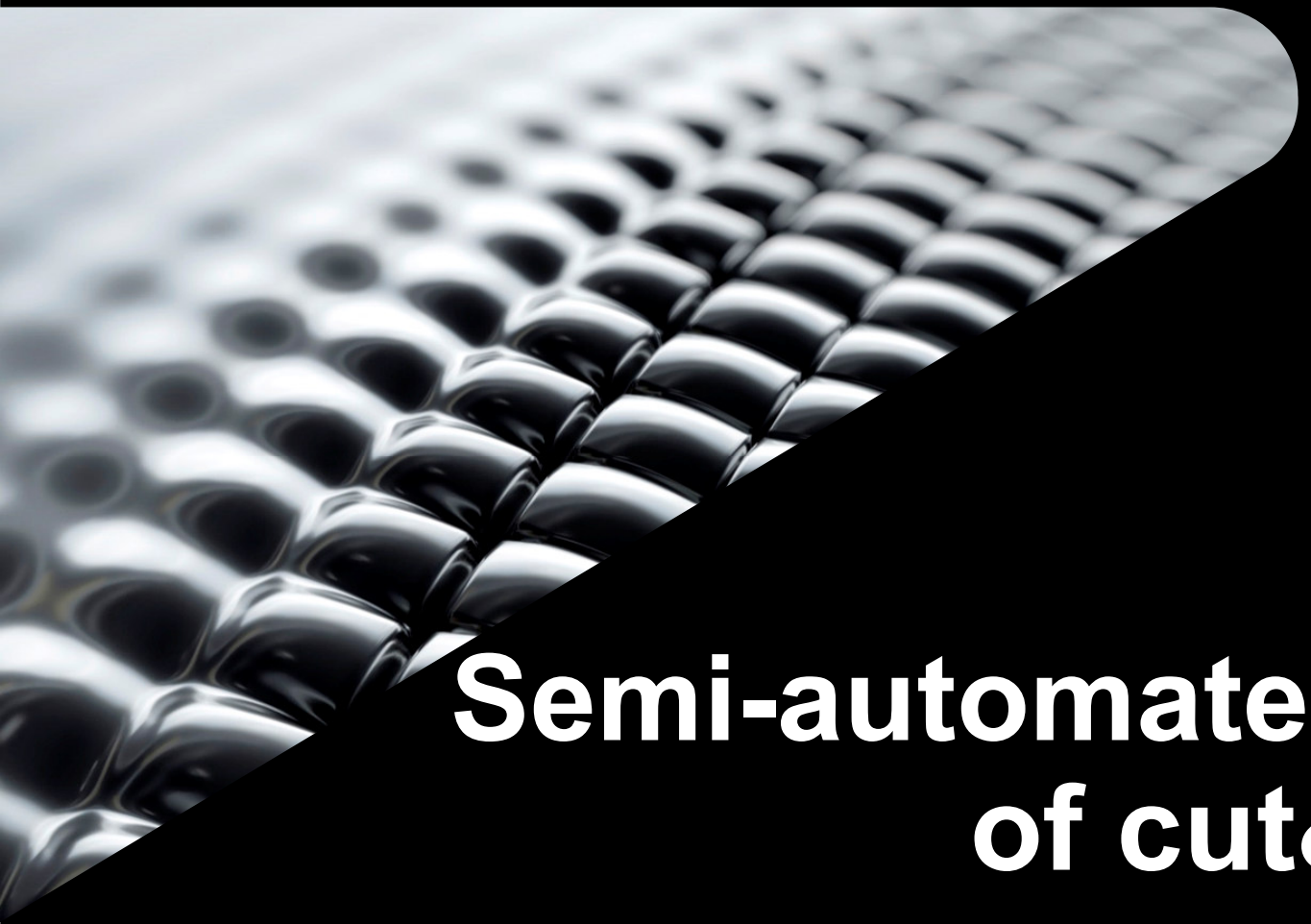
esri
THE SCIENCE OF WHERE

Virtual construction site management

Cancello Frasso Telesino Railway



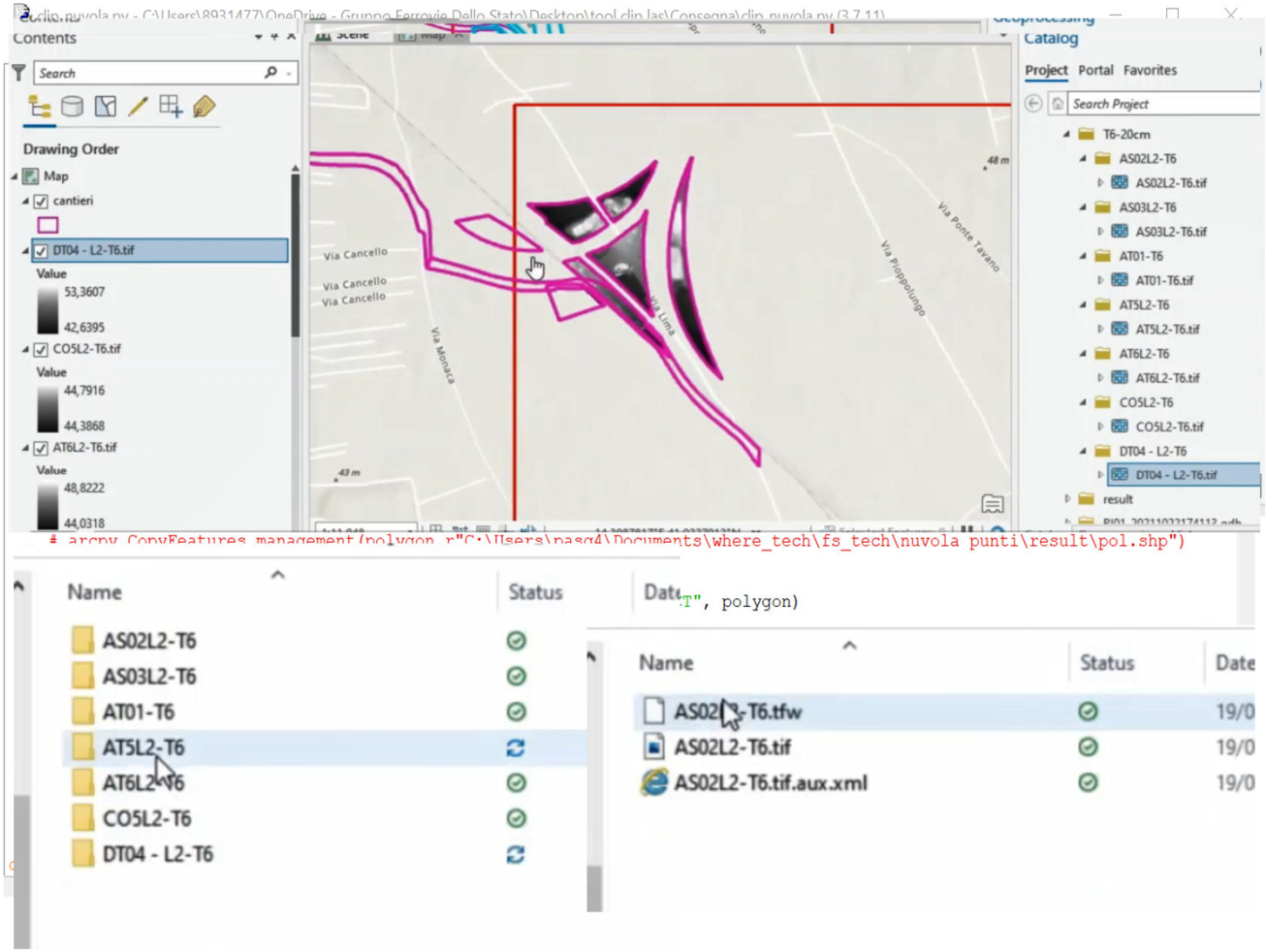
Technical Instruction



Semi-automated calculation of cut&fill volumes

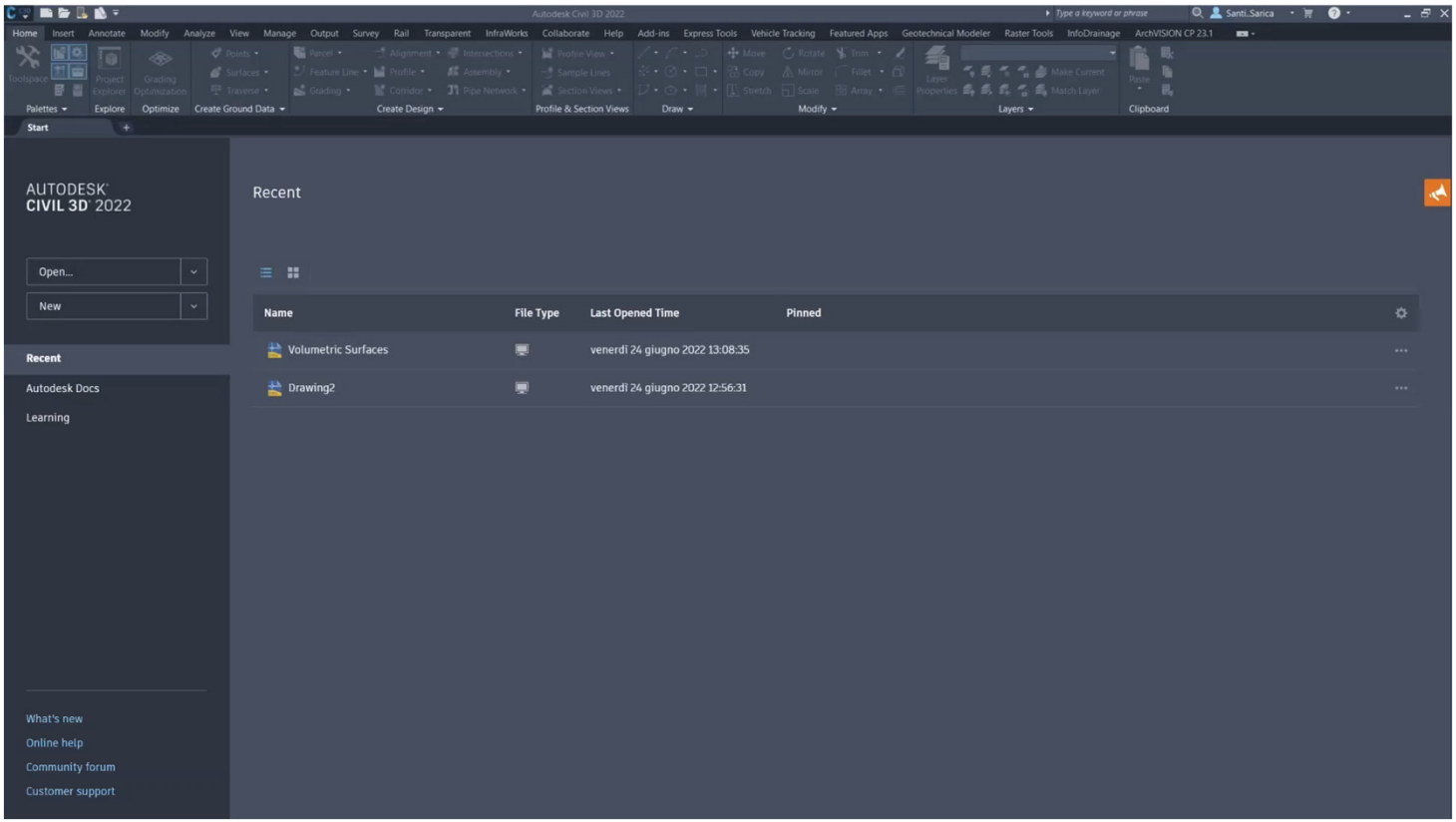
Data preparation

- Point Cloud Management:
  - Classification and Ground Level
  - .las files merge
- Construction Site Feature Classes
  - Area name as a data attribute
- Python Script :
  - DEMs trimming by area
  - Renaming area + survey suffix



Creating the volumetric surfaces - Civil3D

- Civil 3D Template
  - Lightweight style
  - Geographic reference system
- GeoTIFF import
  - Create Surfaces from DEMs
  - Save as .dwg
- Dynamo Routine
  - Create volumetric surfaces
  - Rename to include info on the surveys compared
  - Export .xlsx reports



Creating the volumetric surfaces - Civil3D

- Dynamo Script
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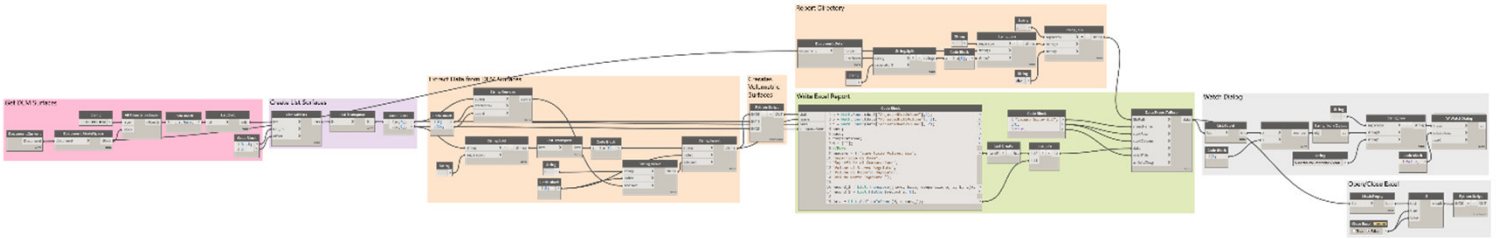
  - Watch Dialog



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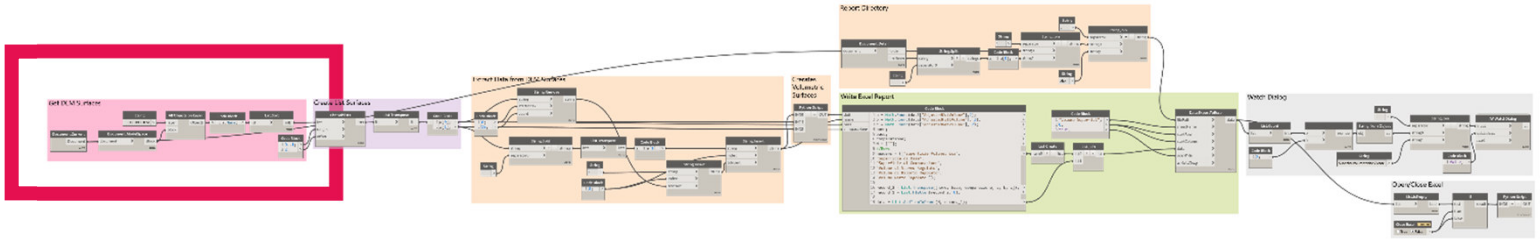

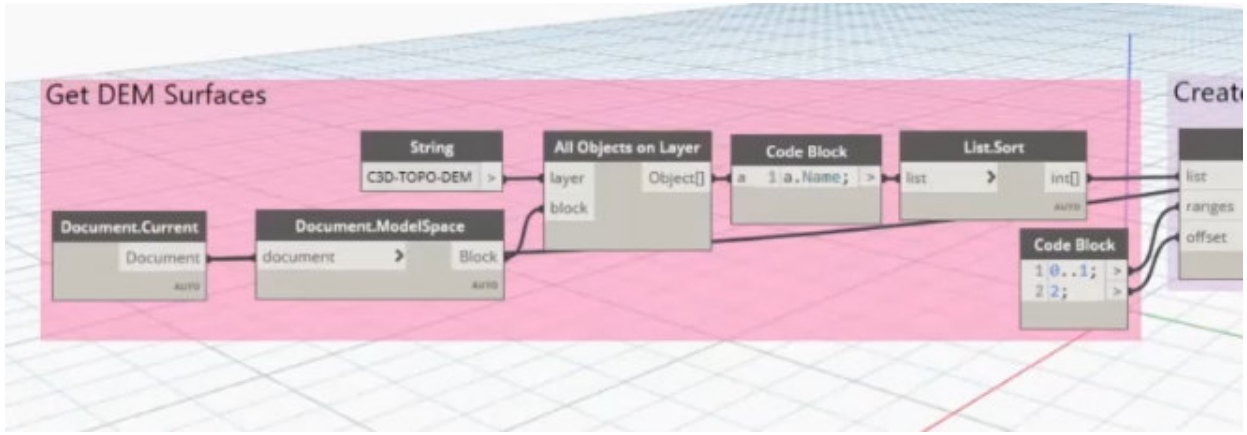

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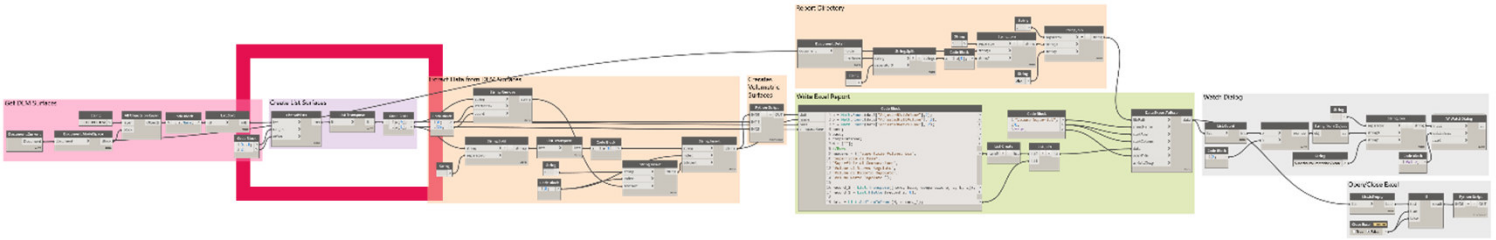

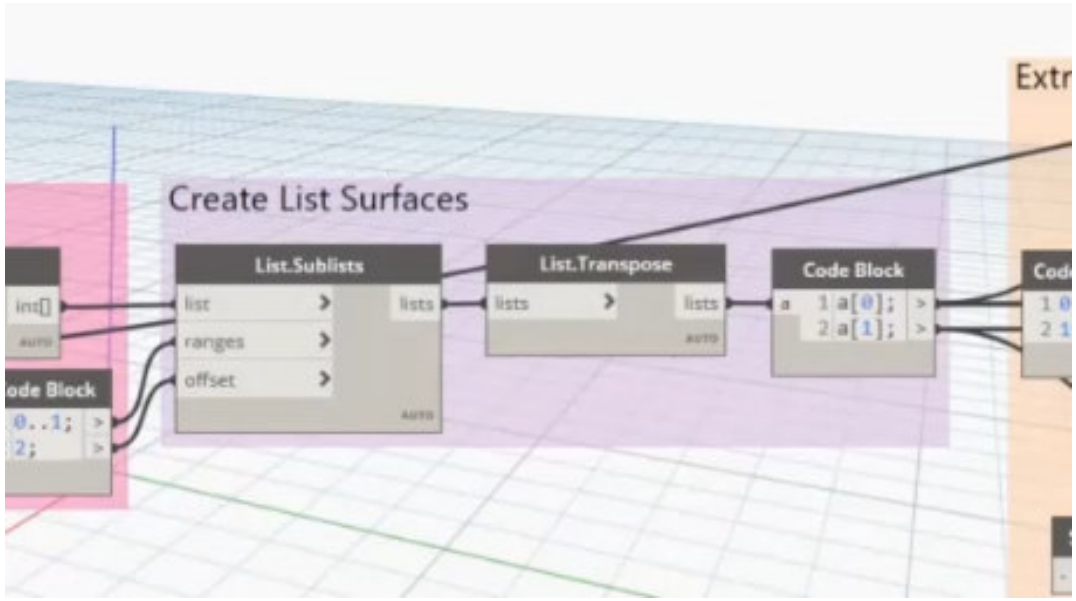

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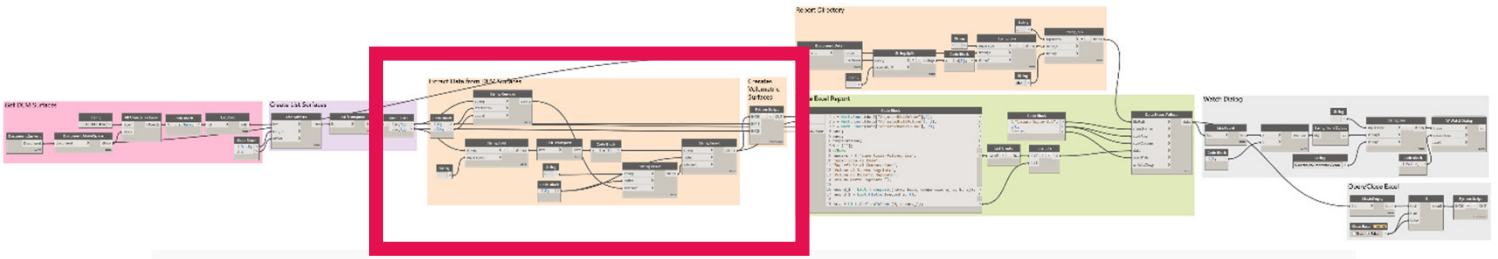

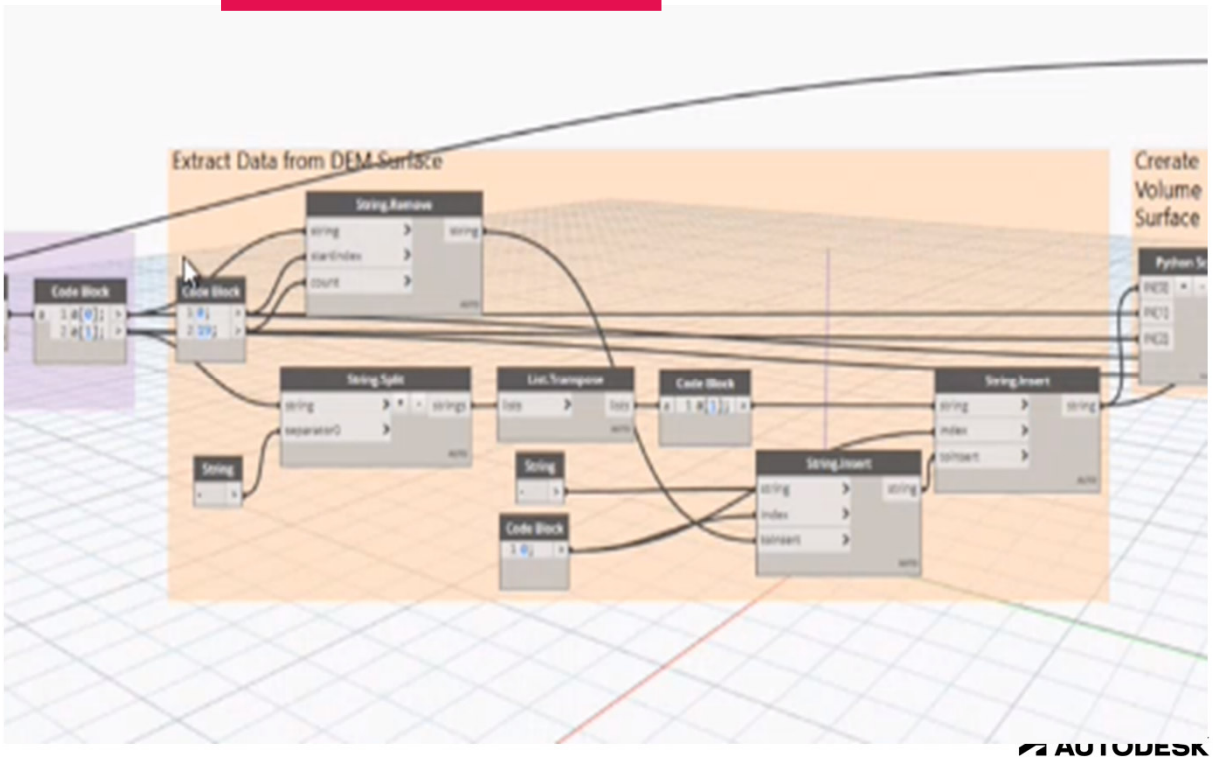

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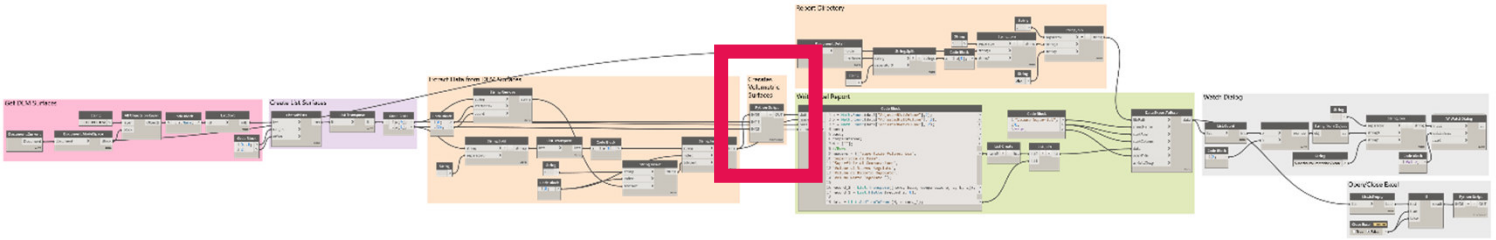

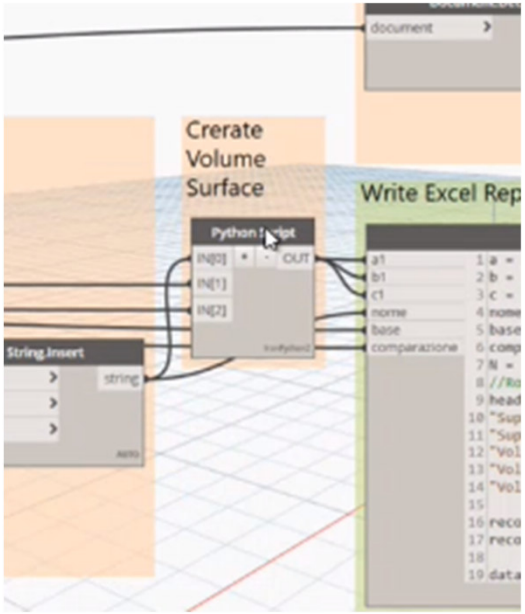

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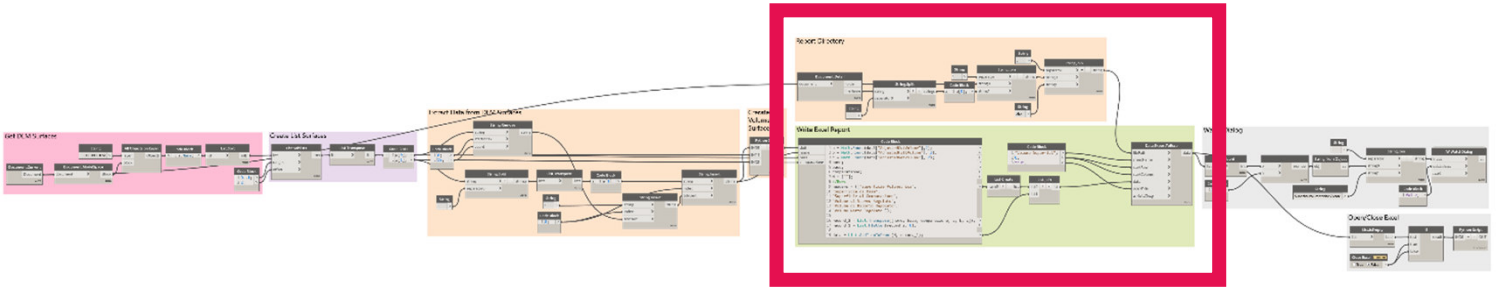

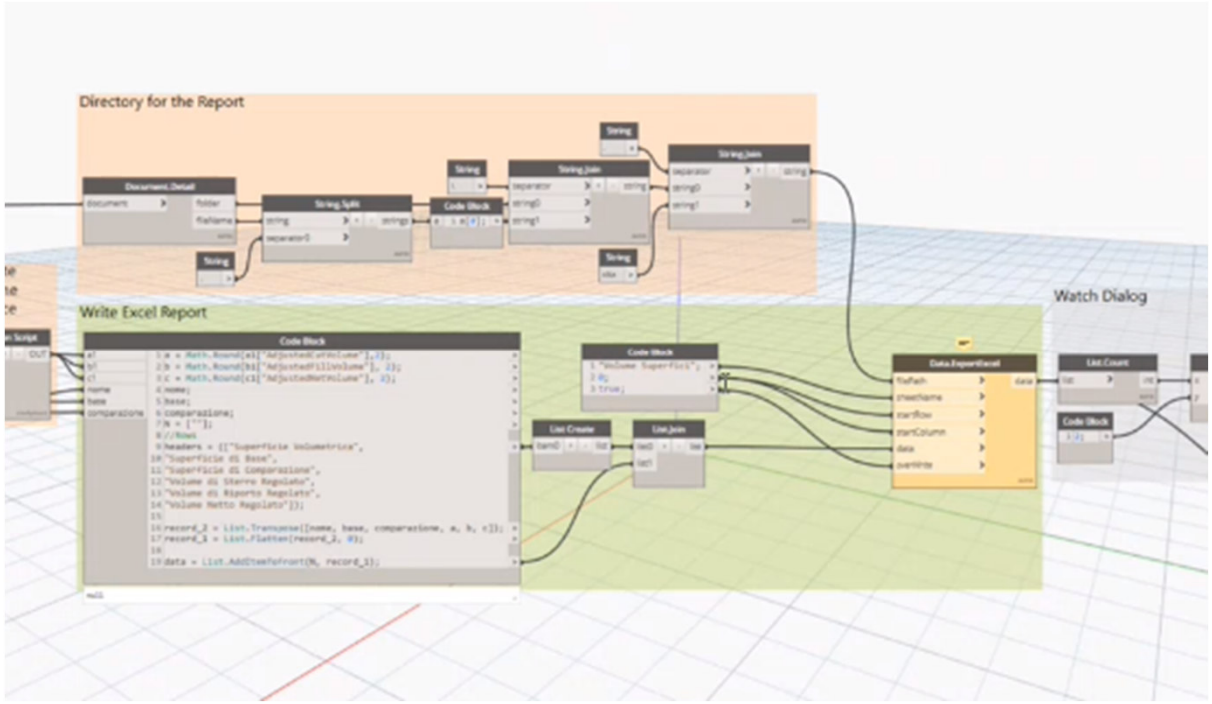

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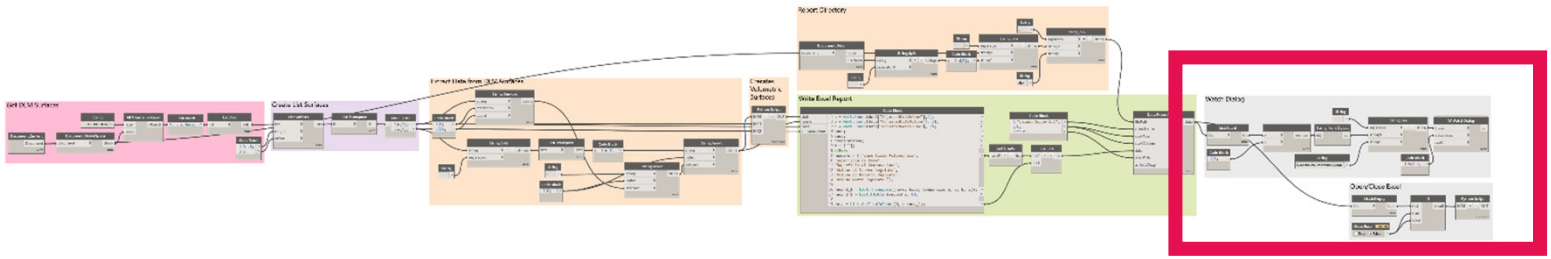

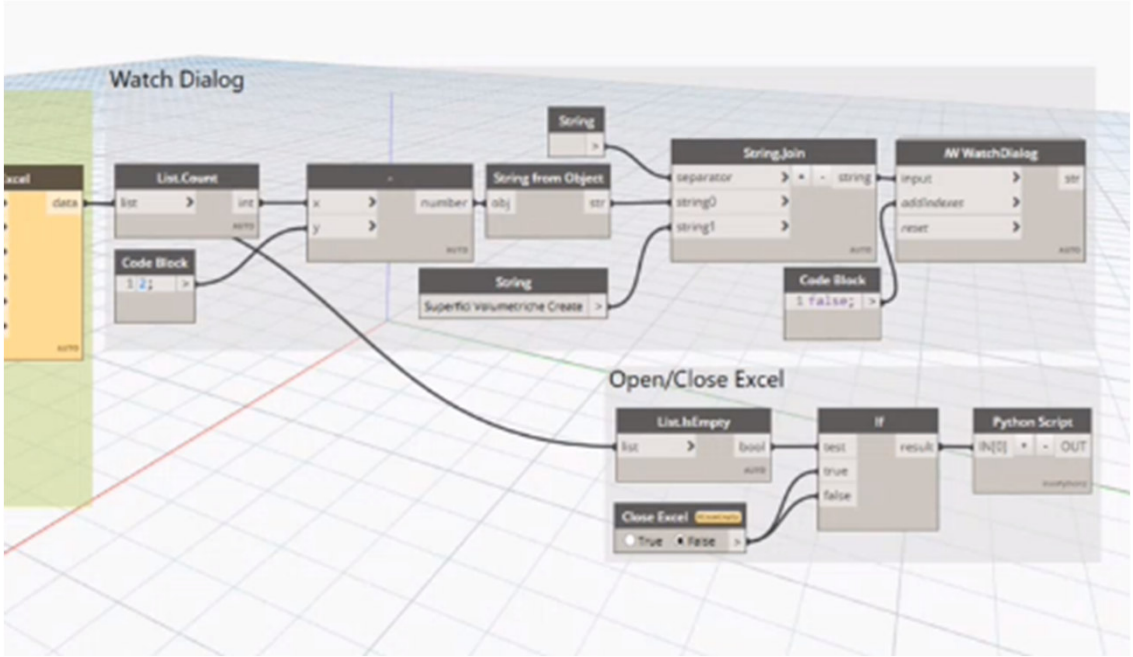

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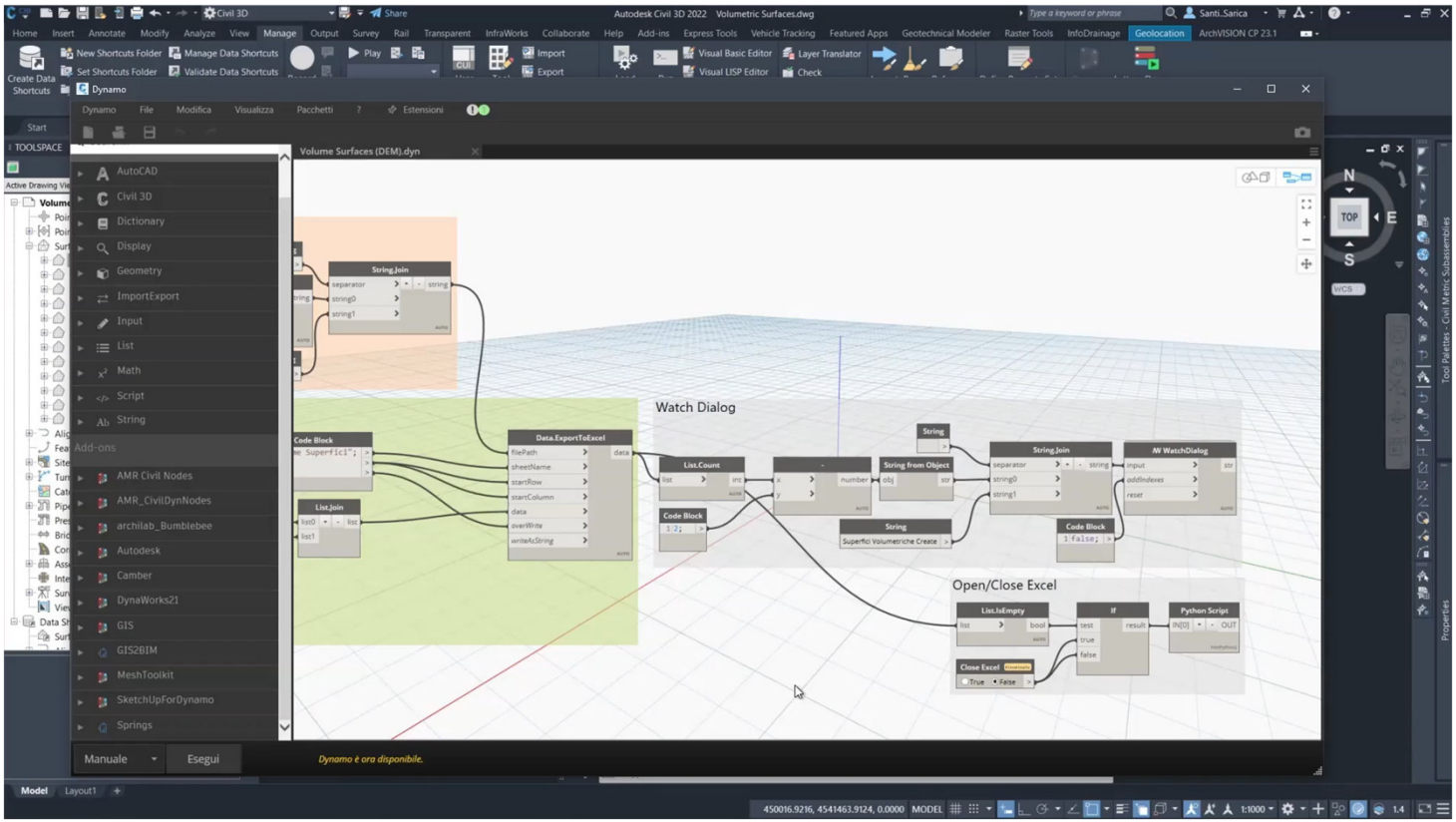
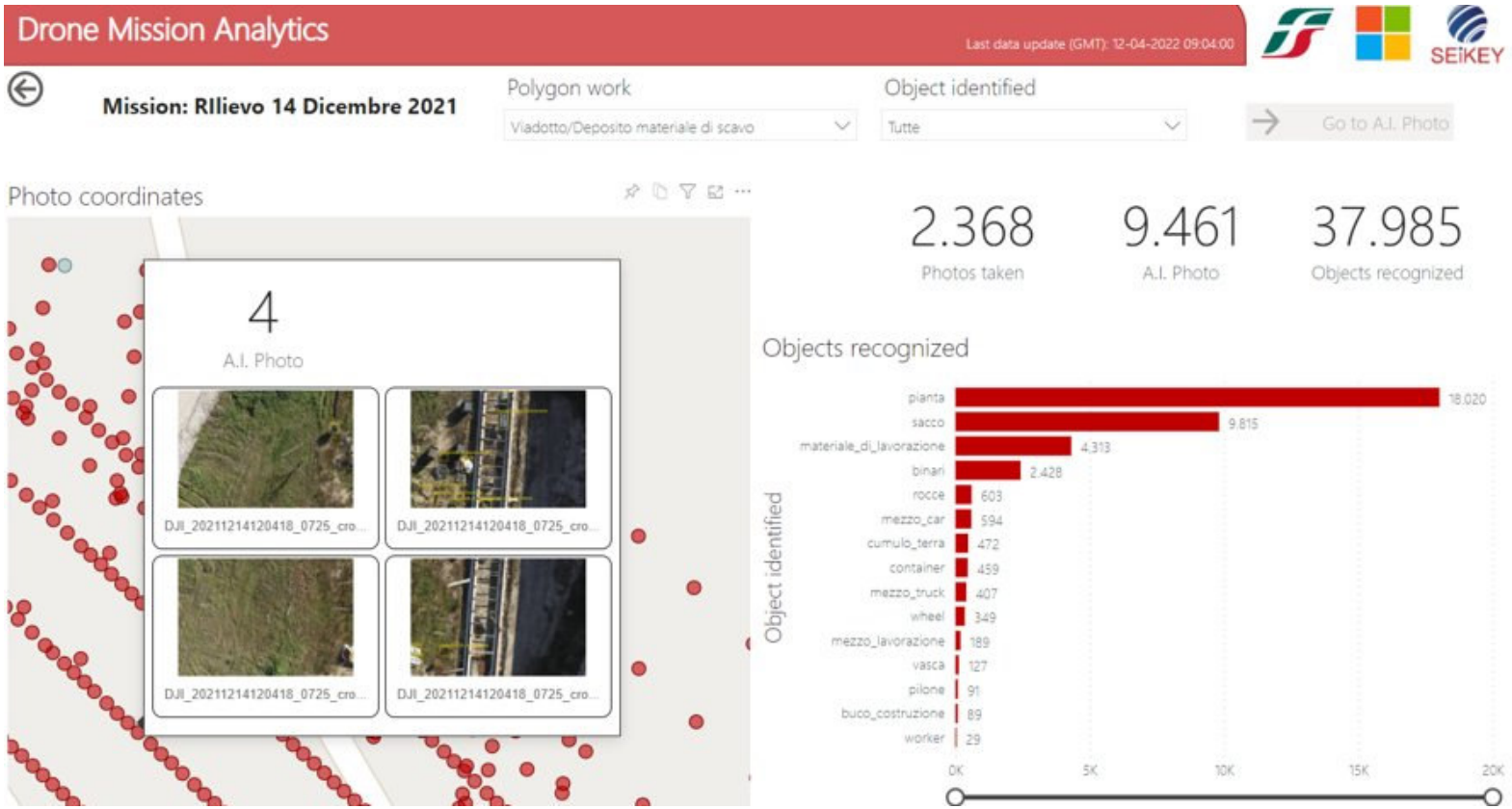


Building the Project Dashboard

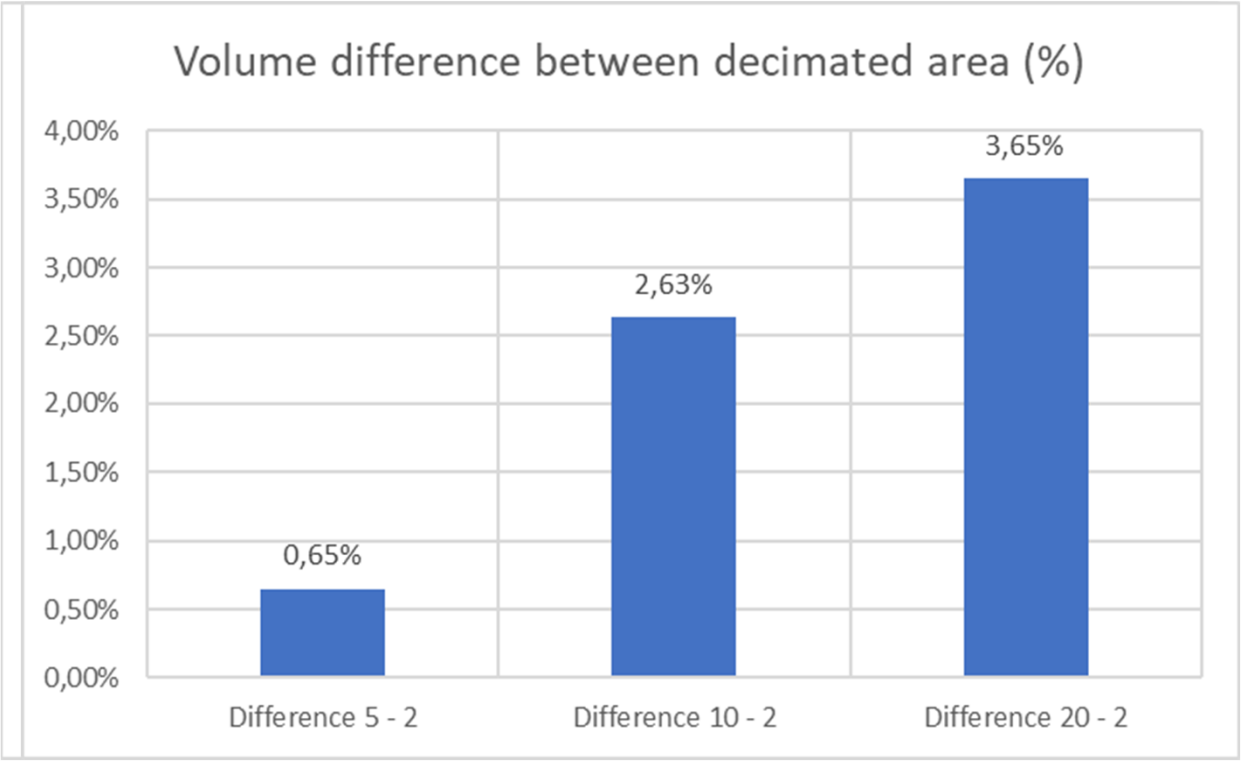
- The reports extracted suitable for Business Intelligence tools

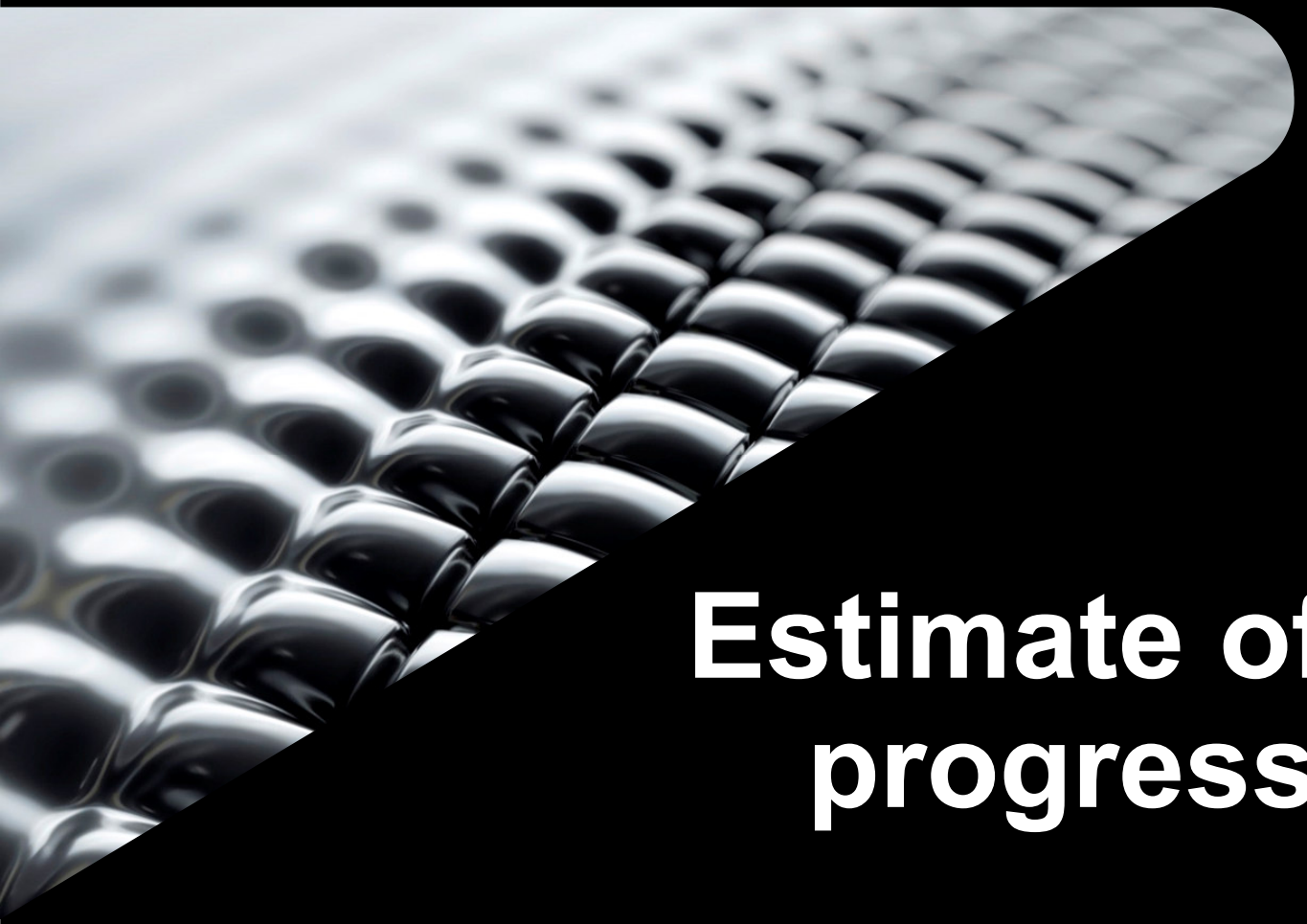
- Project dashboard to interrogate and visualize on a map



Workflow analysis
Estimating processing time and accuracy

- Result:
  - Point cloud decimation
  - DEM processing
  - Surfaces genaration in Civil 3D

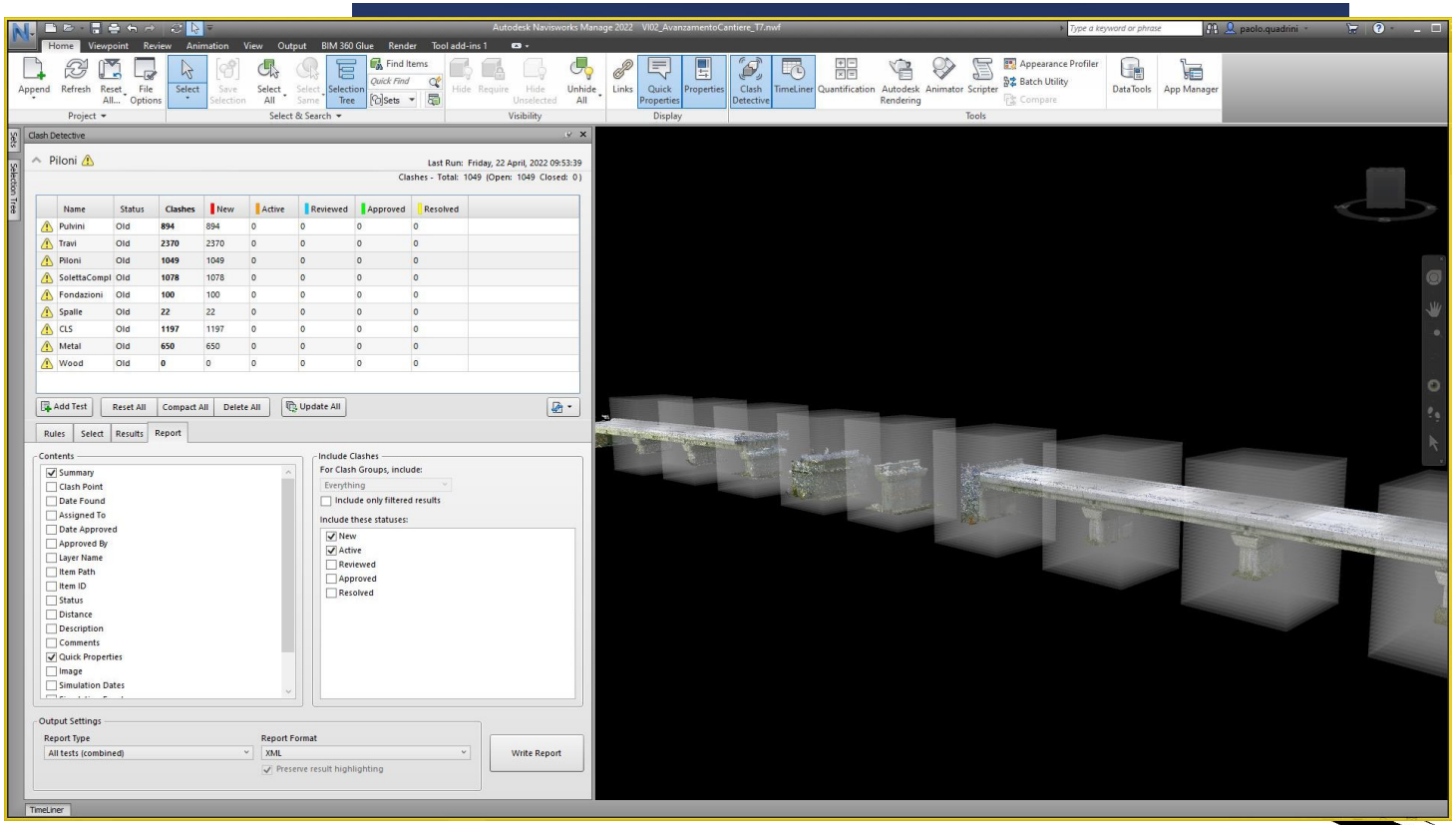




Estimate of the physical progress of the works

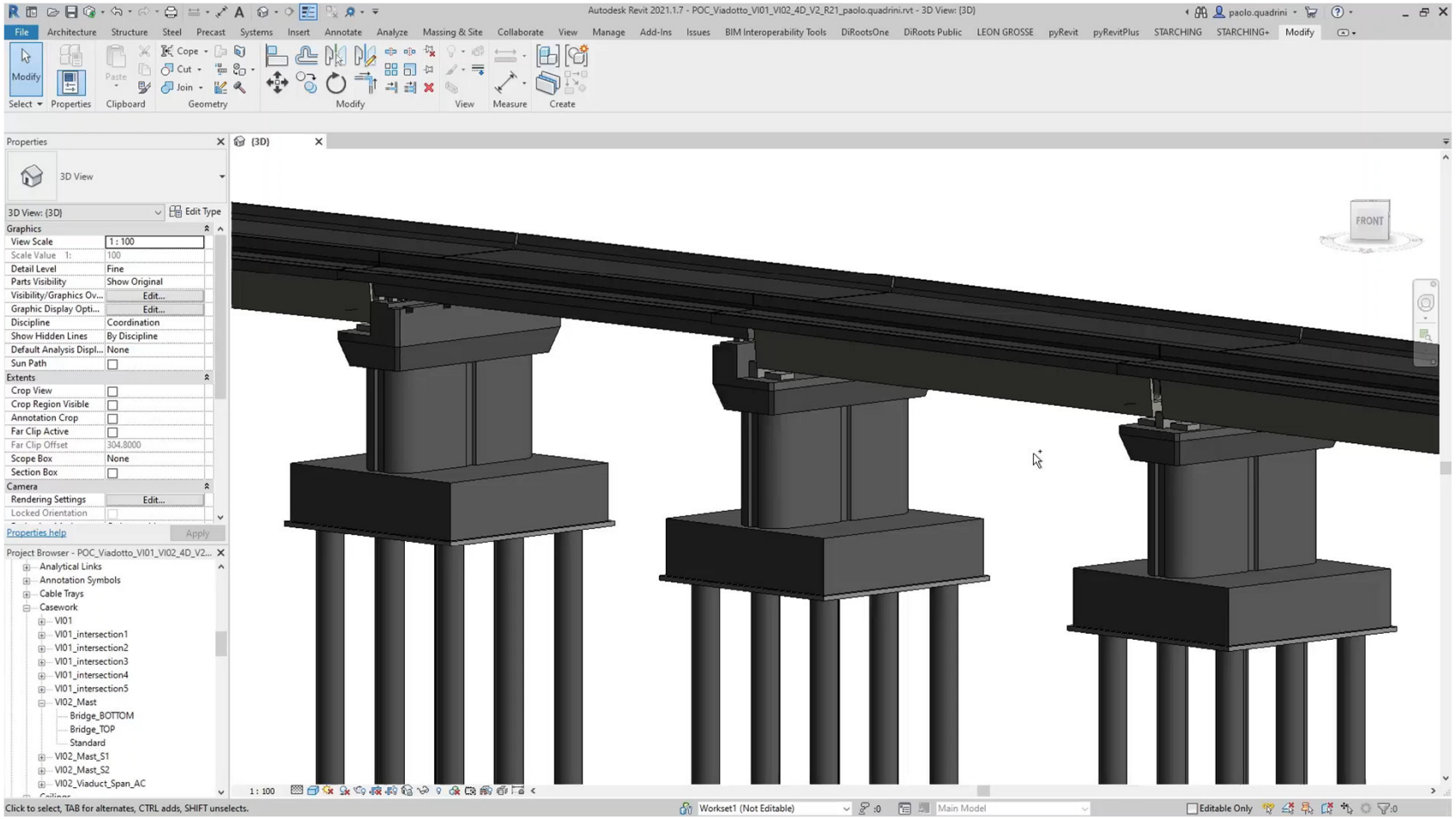
Solution for Calculating the Physical Progress of Infrastructures

- Physical Progress of the Structures
  - True model
  - Simplified model
- Railway Embankments
- Navisworks Clash Detection
- Calculation algorithm and dashboard data integration



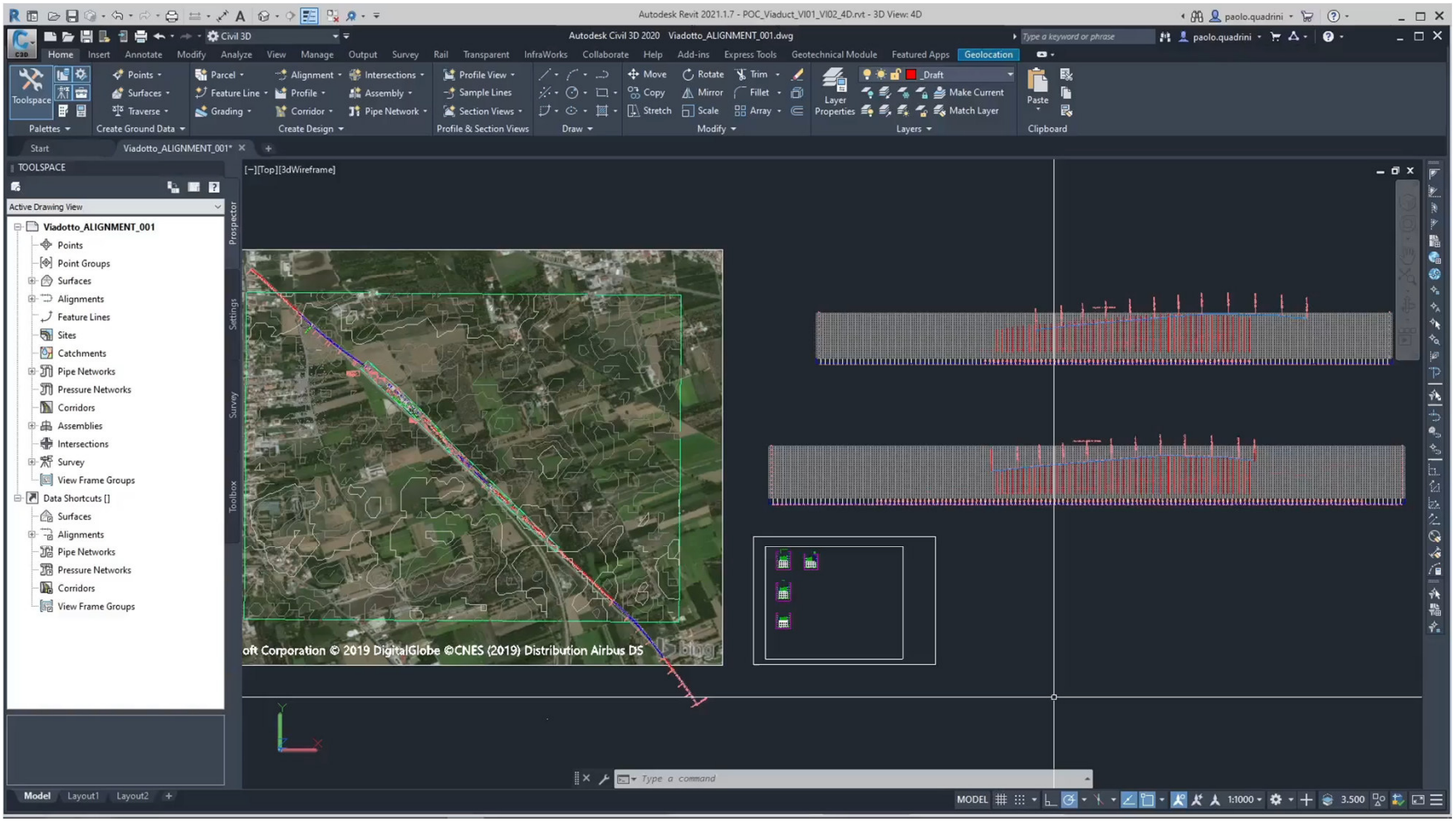
Physical Progress of Viaducts – True BIM Model

- Pre-loaded families
- Parameters



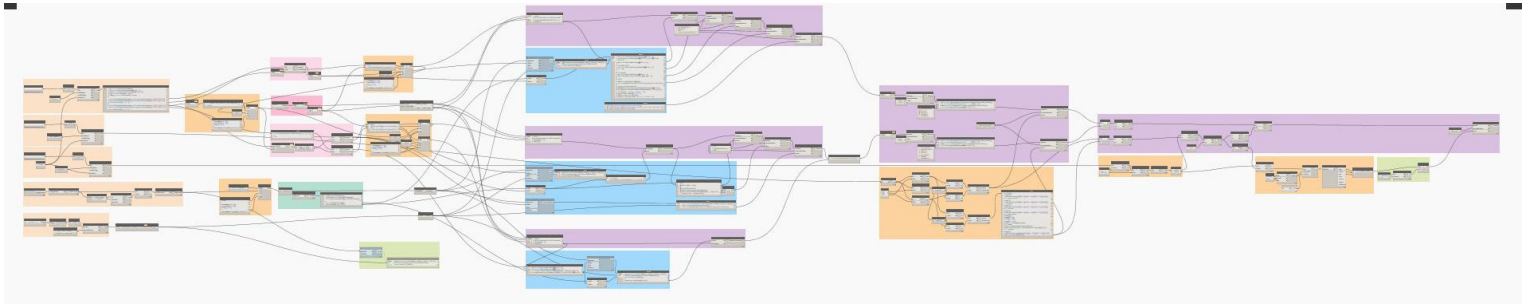
Physical Progress of Viaducts – True BIM Model

- Civil 3D Project
  - Path and elevation
- Shared coordinates
- Blank Revit project
- Dynamo Script



Physical Progress of Viaducts – True BIM Model

- Dynamo Script
  - Input
  - Graphic User Interface
  - Manage data to build Revit elements
  - Manage data to visualize Revit parameters



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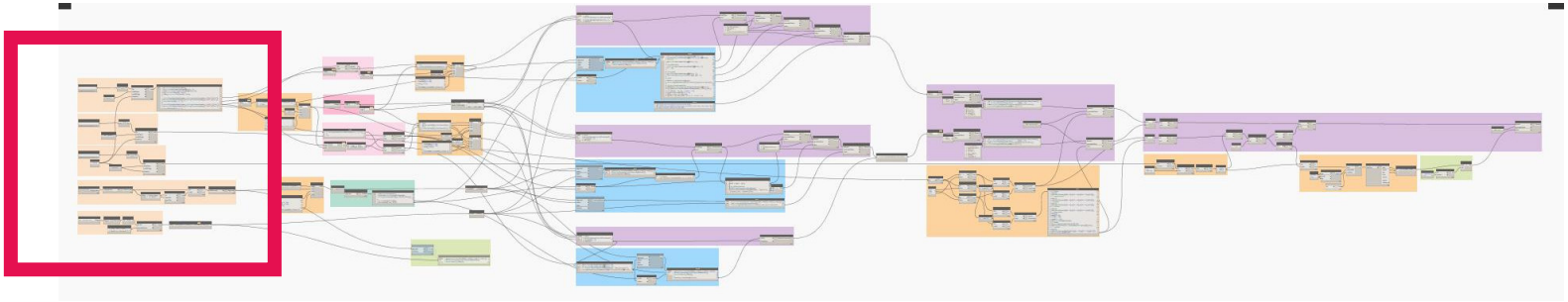

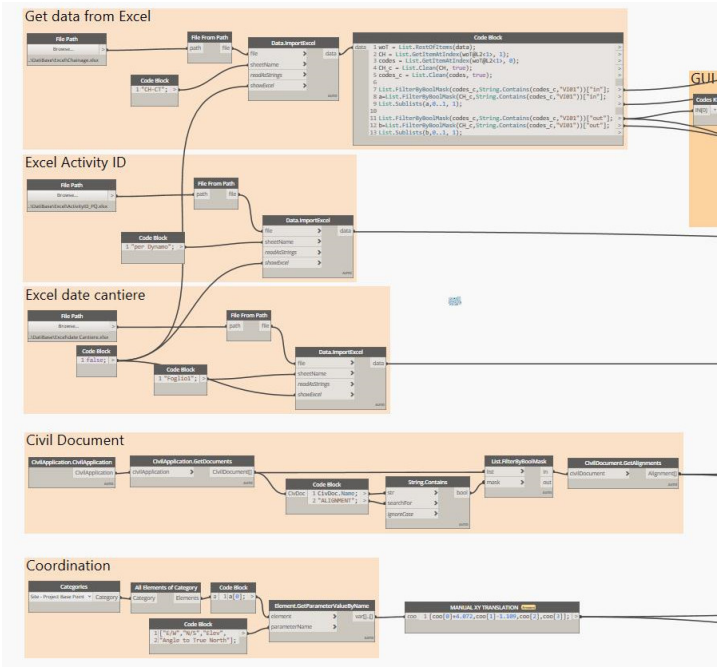

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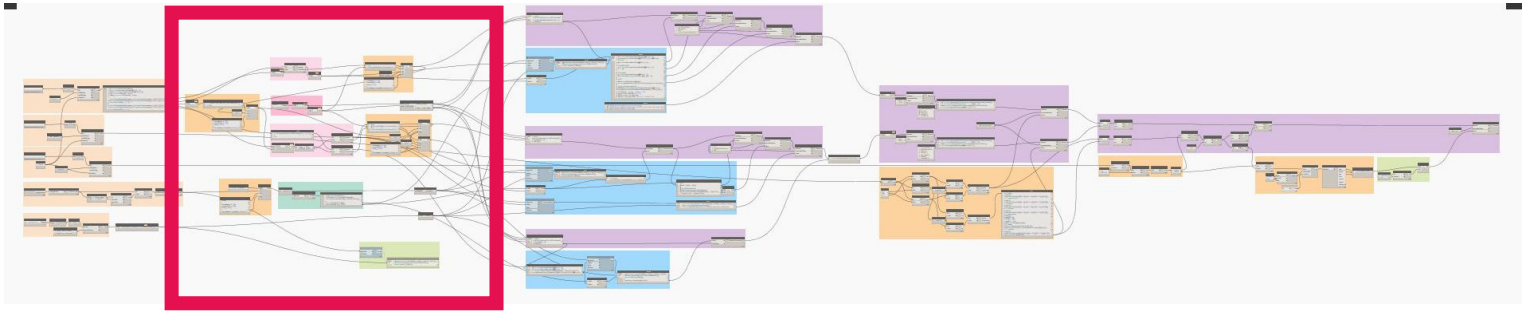

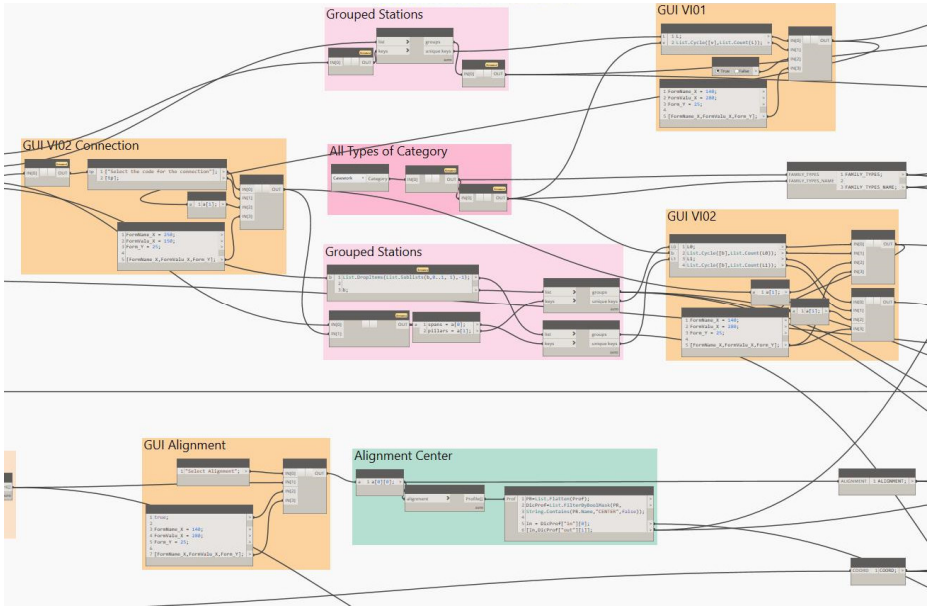

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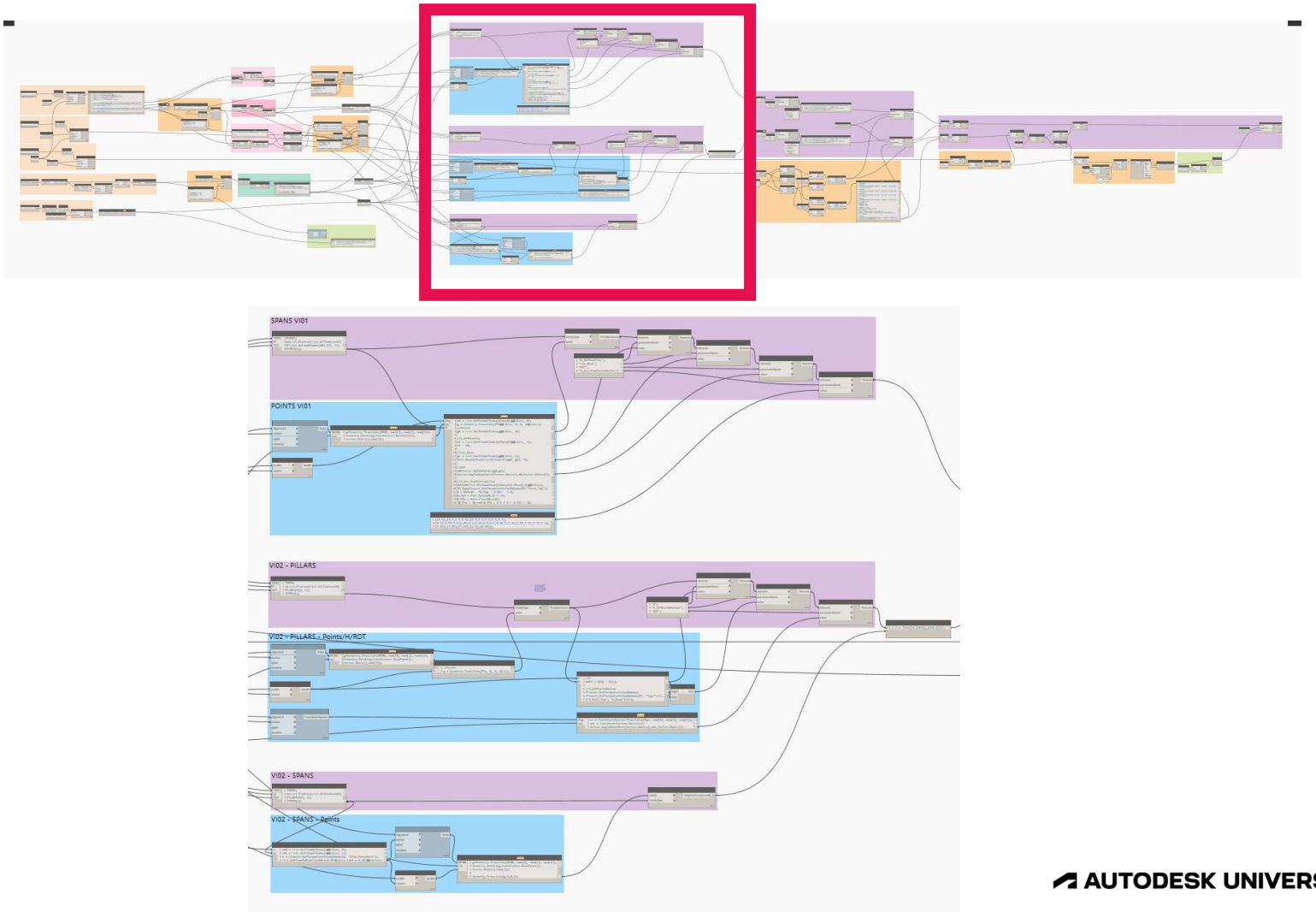

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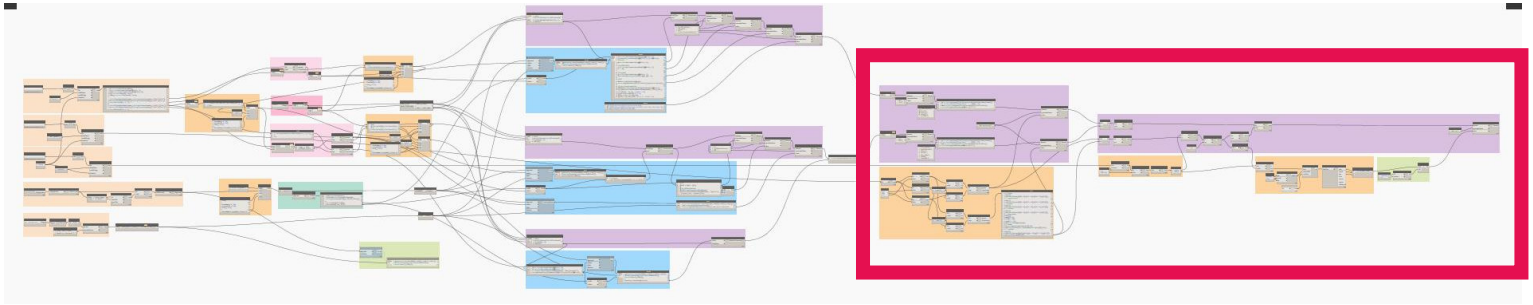

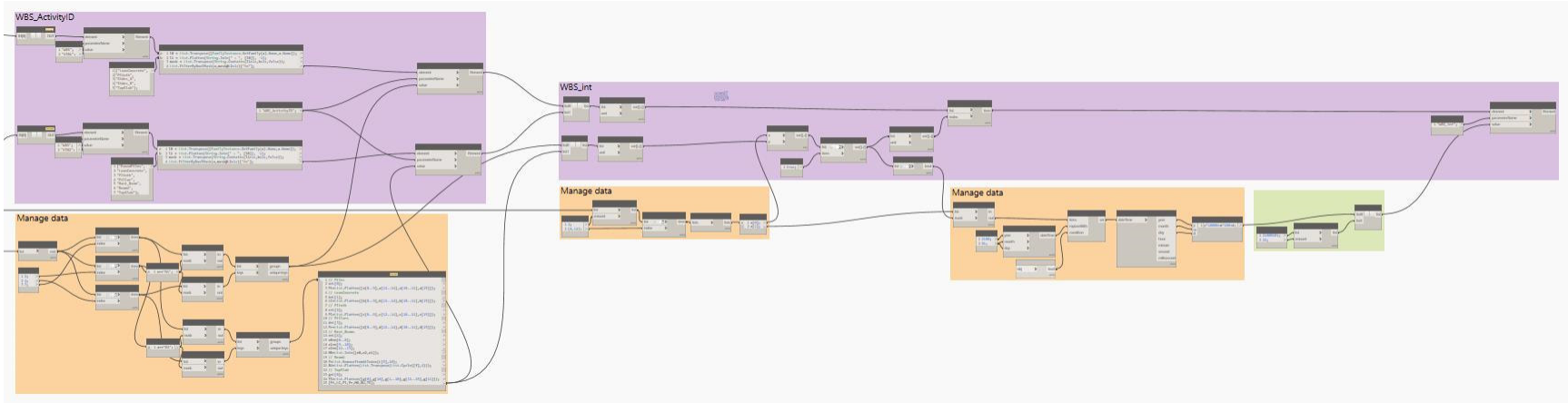

Physical Progress of Viaducts – True BIM Model

- Civil 3D Project
  - Path and elevation
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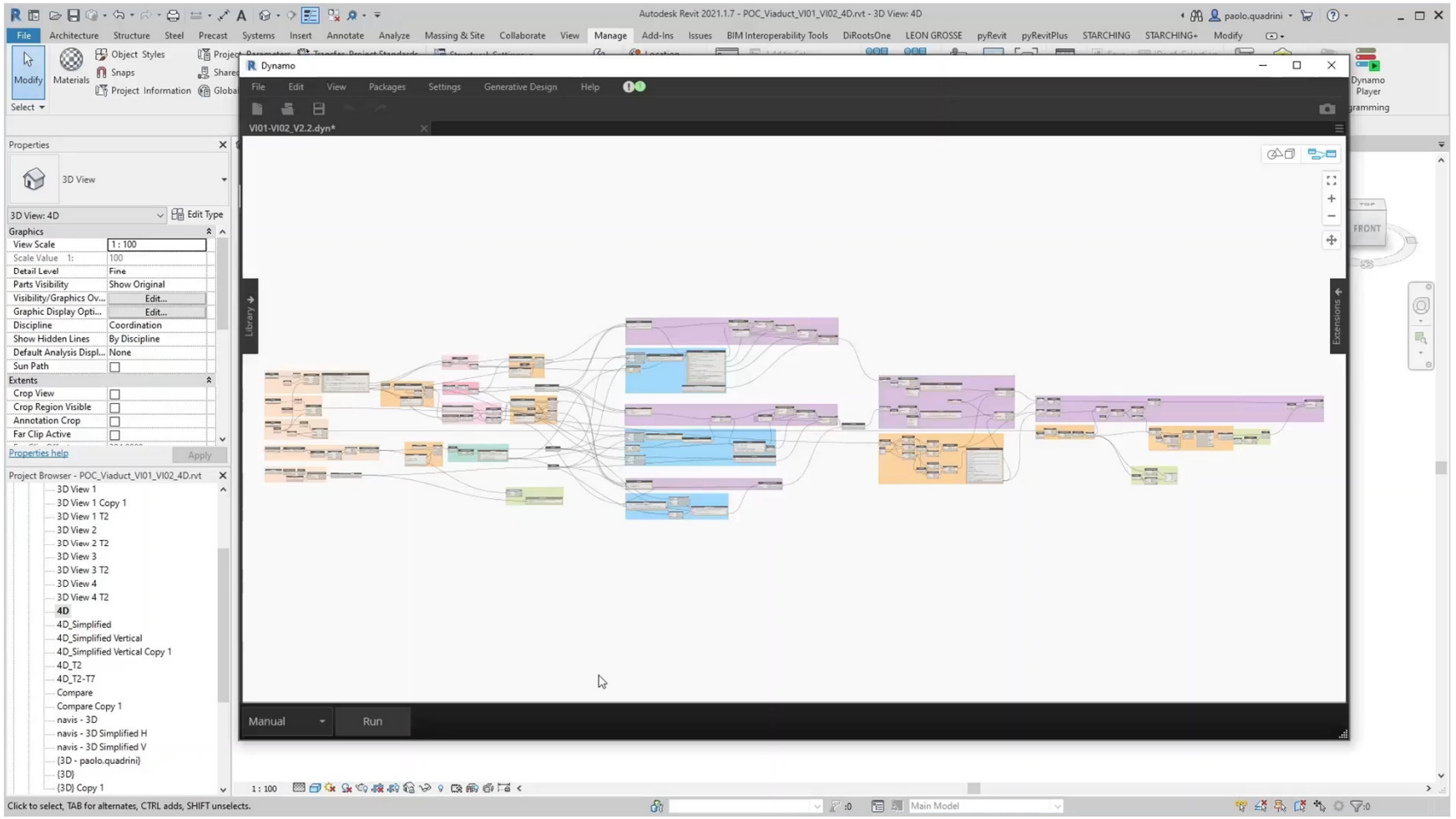
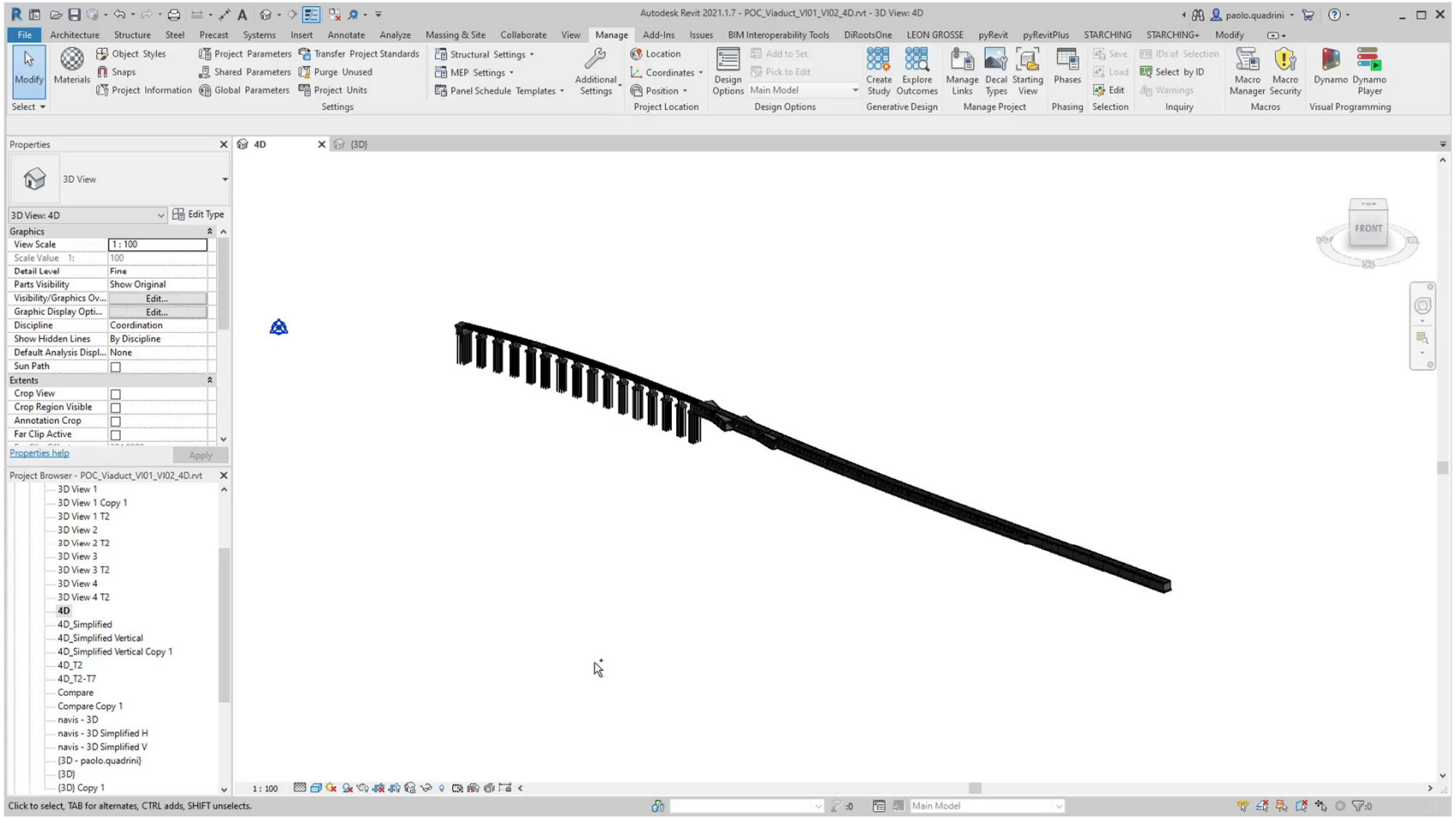
- Blank Revit project
- Dynamo Script



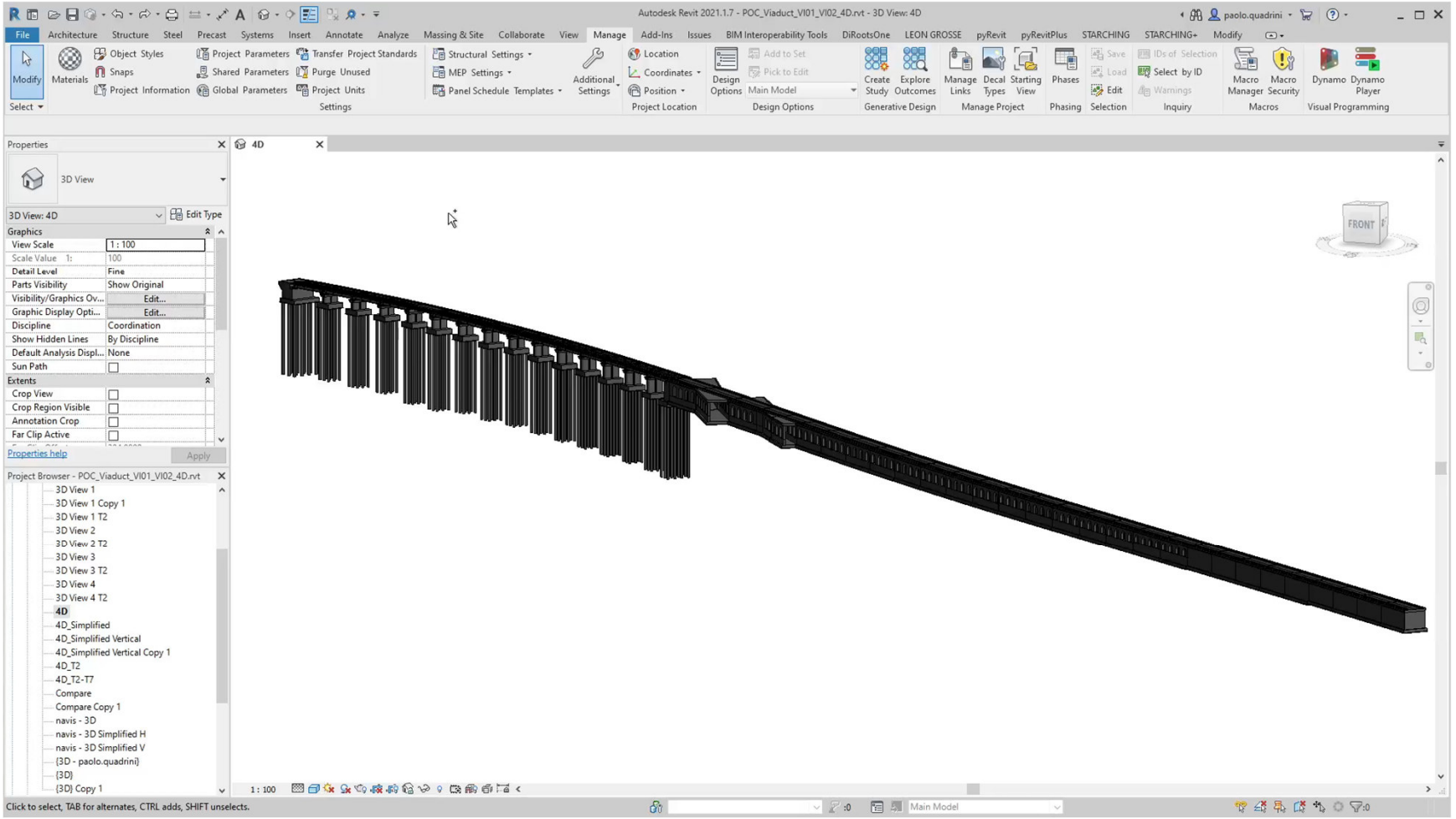
Physical Progress of Viaducts – True BIM Model

- Revit
  - Elements placement
  - Parameters population
  - NWC Export



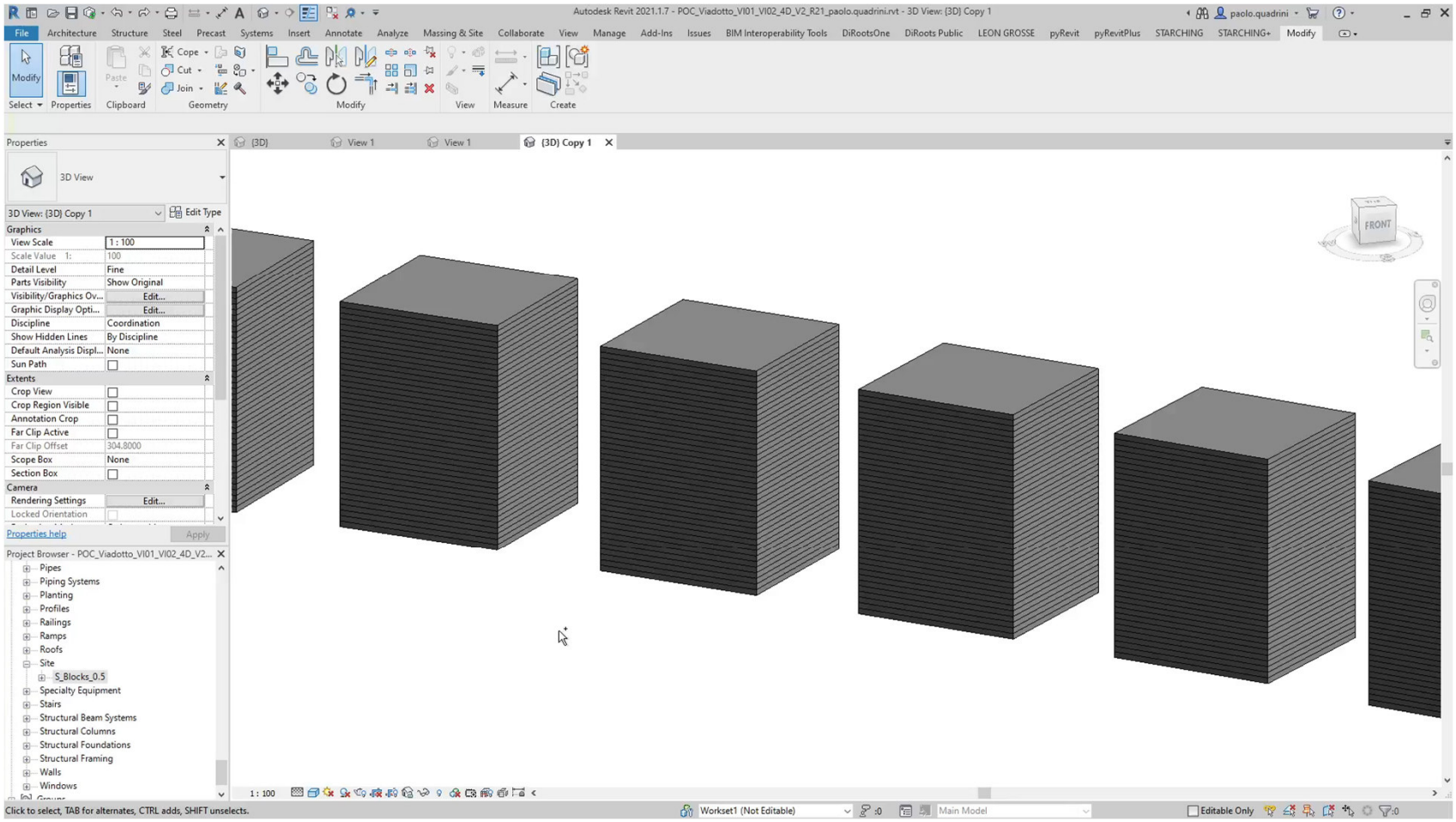
Physical Progress of Viaducts – True BIM Model

- Revit
  - Visualization and analysis of the physical progress

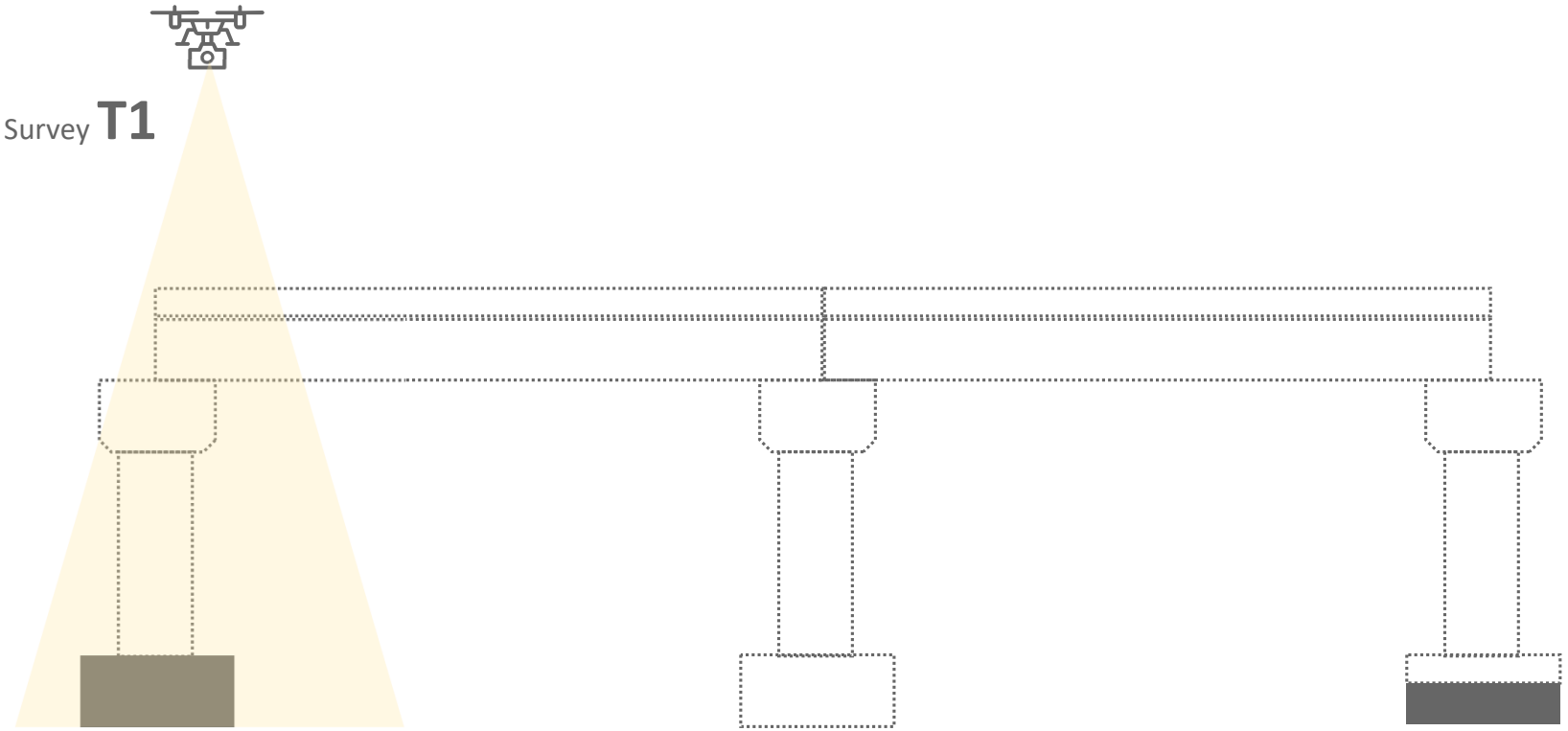


Physical Progress of Viaducts – Simplified Model

- One single family
  - Horizontal plane
- Parameters
  - Zero datum update



Physical Progress of Viaducts – Simplified Model

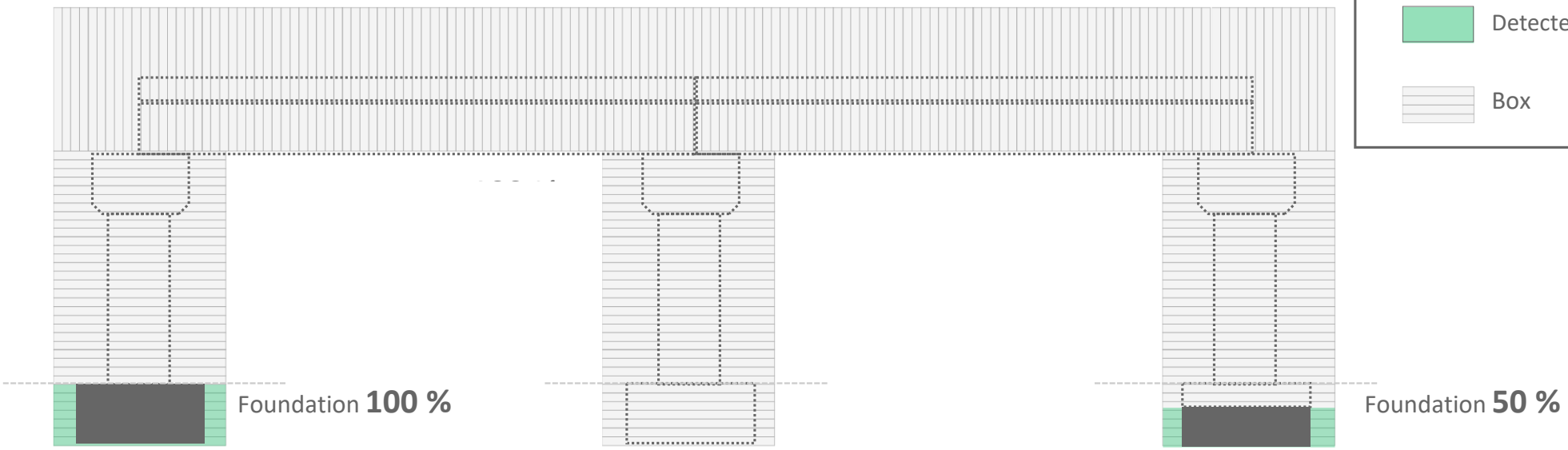


Legend:

- Project Element
- Built Element
- Detected Element

Physical Progress of Viaducts – Simplified Model

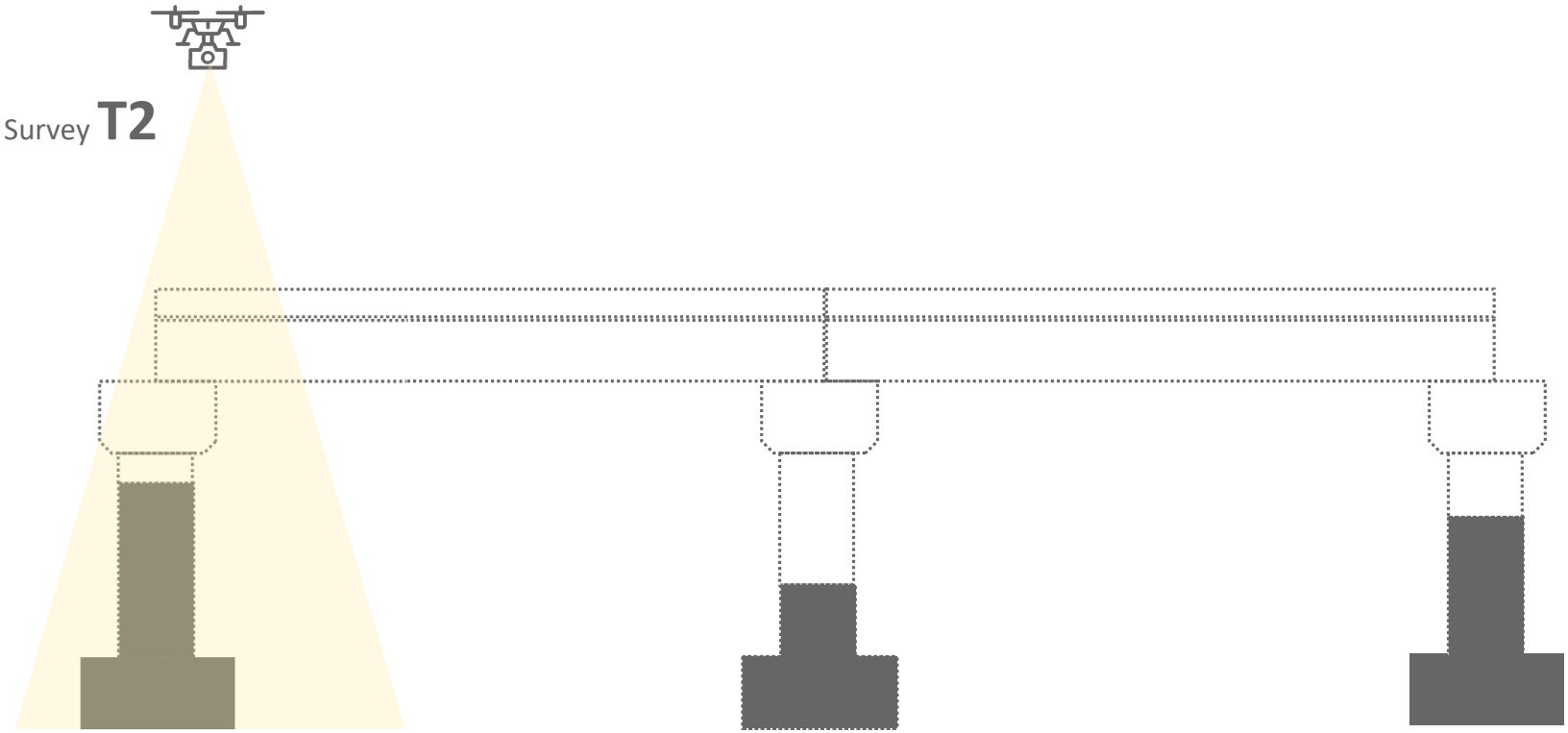
Survey **T1**



Legend:

- Project Element
- Detected Element
- Detected Elevation
- Box

Physical Progress of Viaducts – Simplified Model

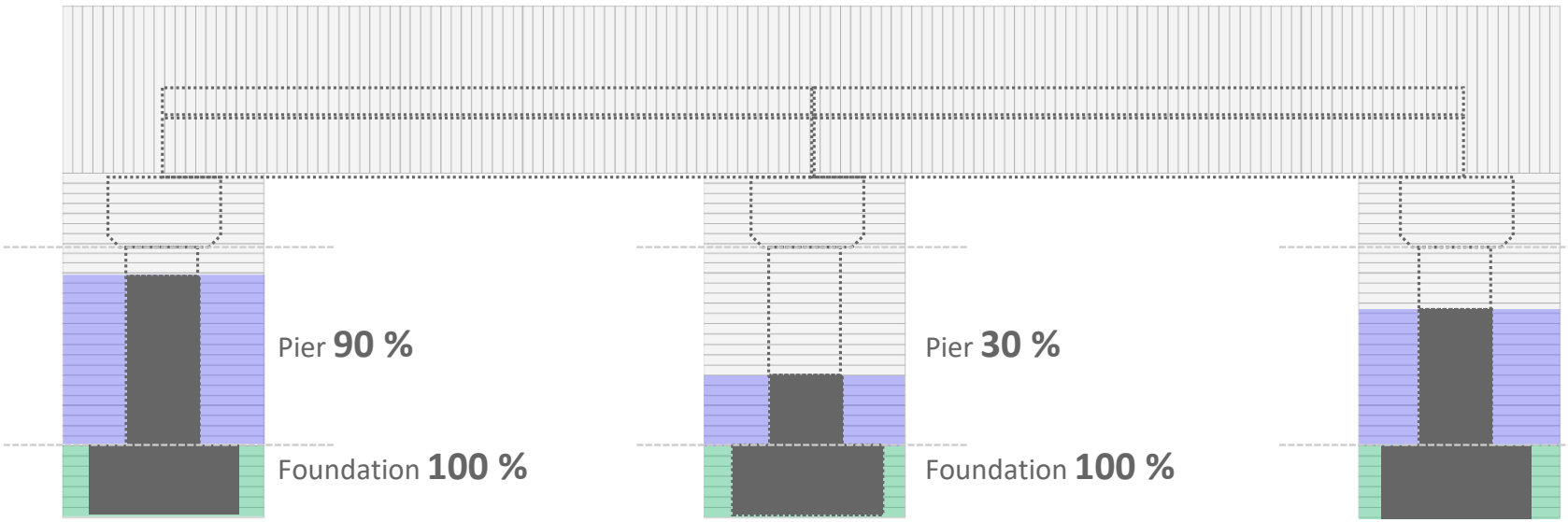


Legend:

- Project Element
- Built Element
- Detected Element

Physical Progress of Viaducts – Simplified Model

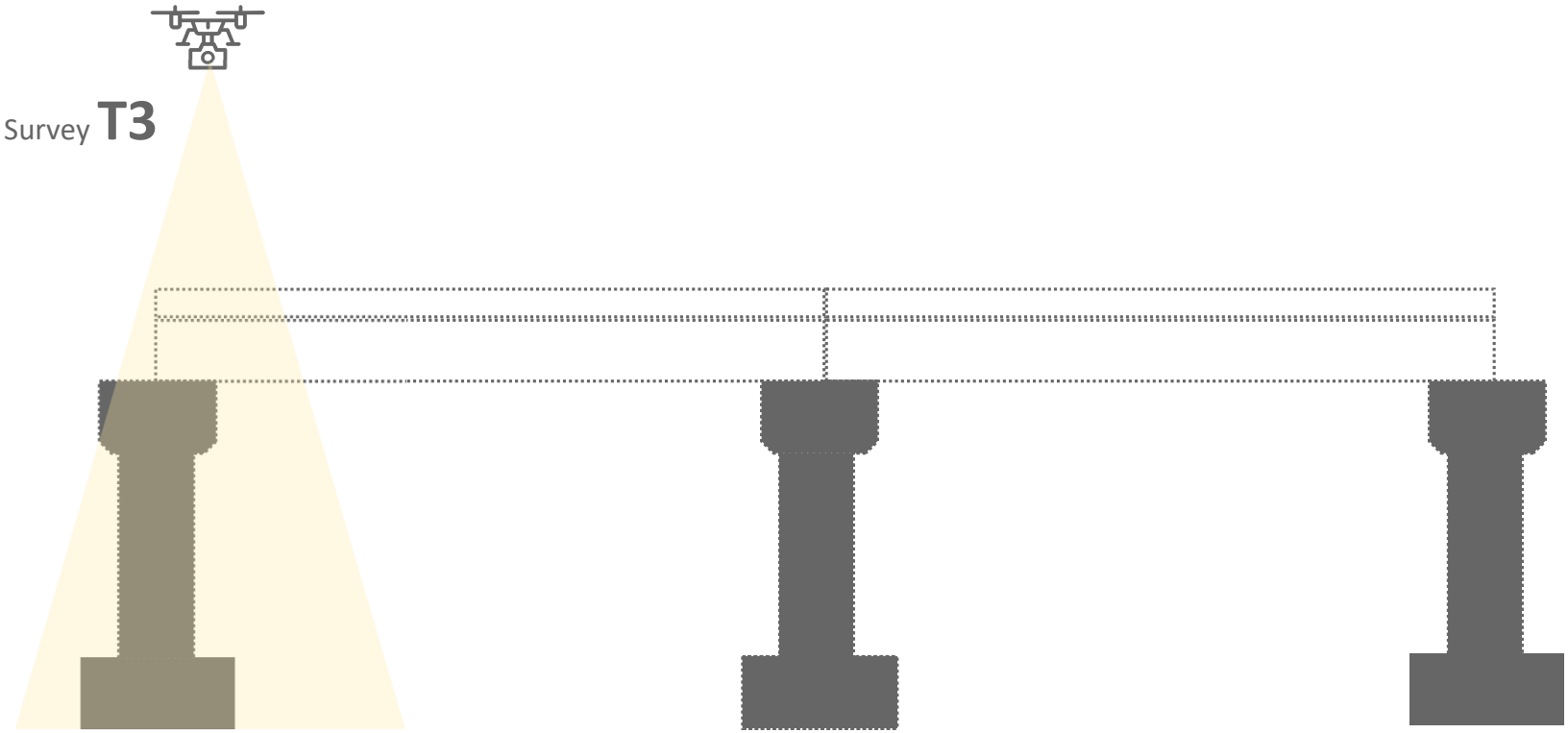
Survey **T2**



Legend:

- Project Element
- Detected Element
- Detected Elevation
- Box

Physical Progress of Viaducts – Simplified Model

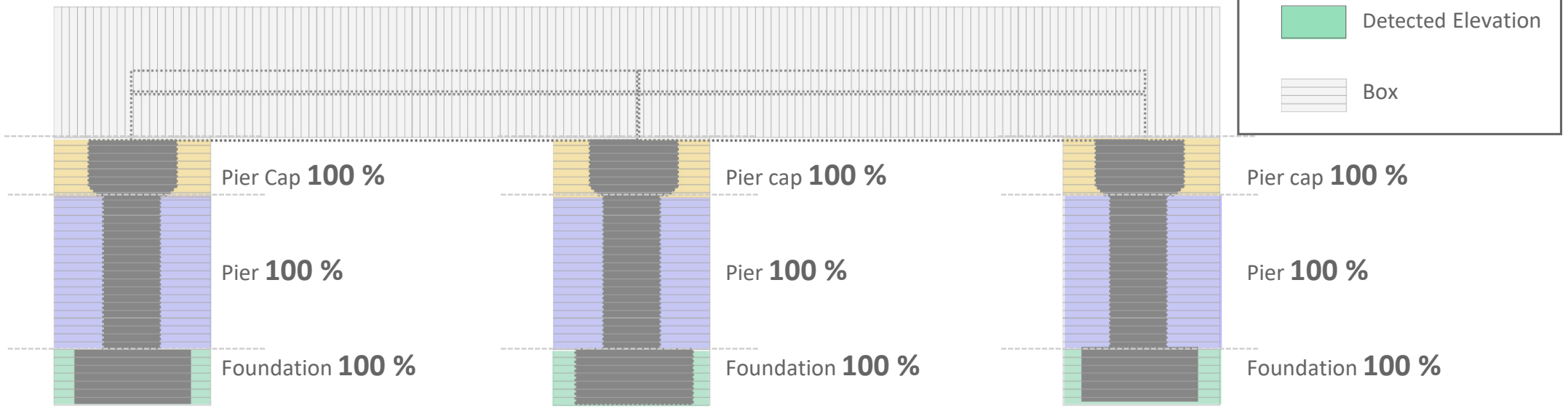


Legend:

- Project Element
- Built Element
- Detected Element

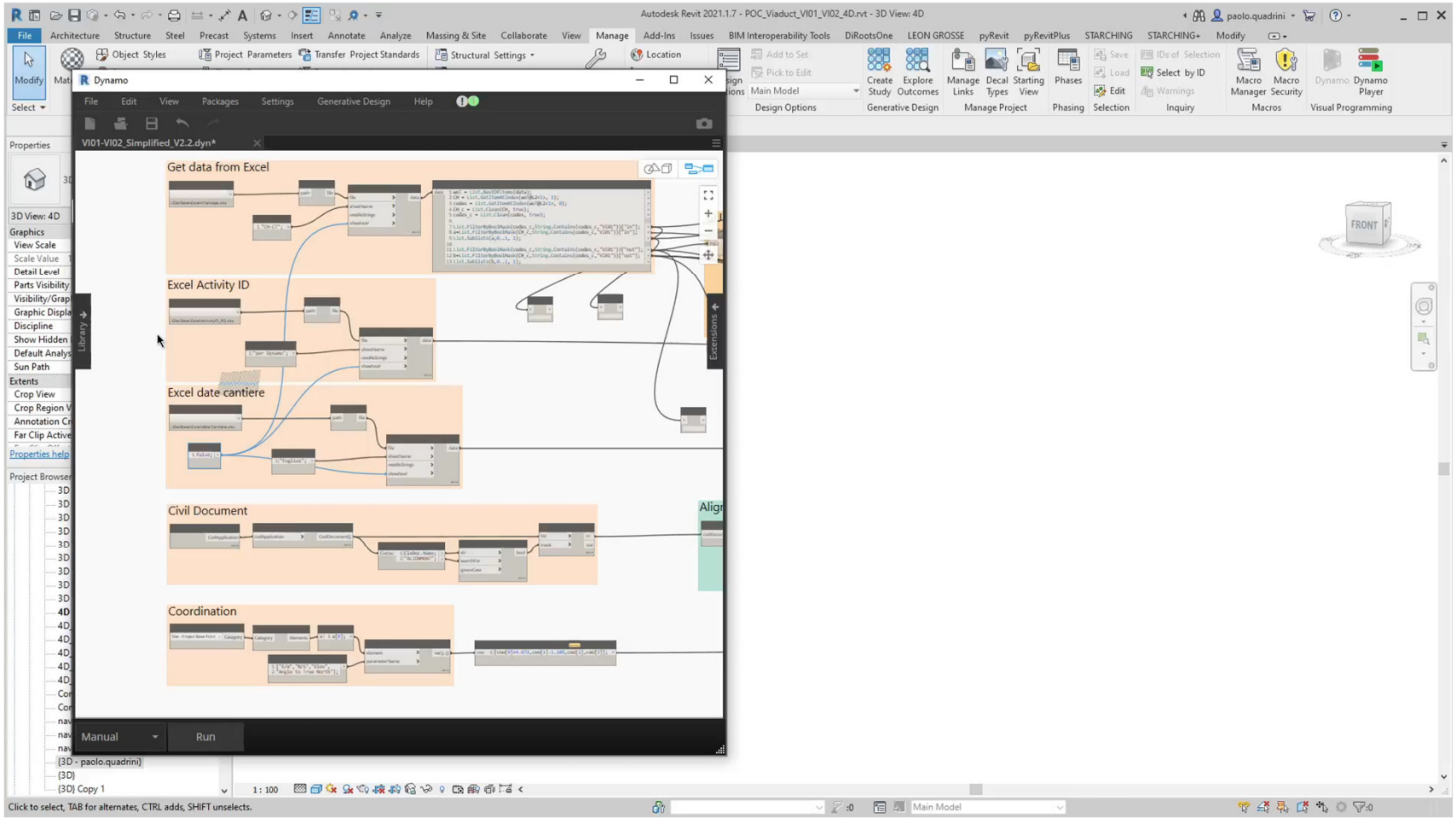
Physical Progress of Viaducts – Simplified Model

Survey **T3**



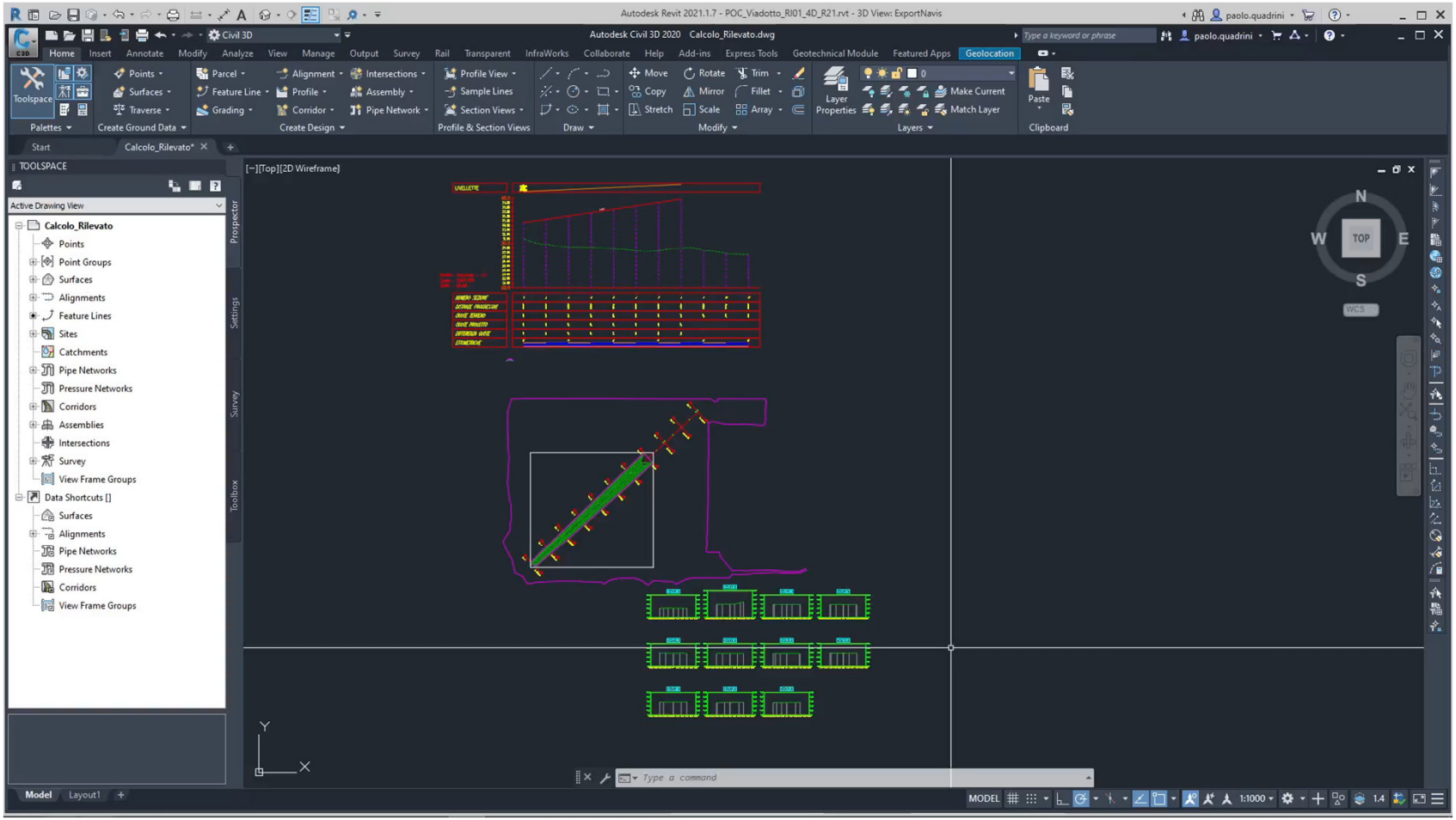
Physical Progress of Viaducts – Simplified Model

- Dynamo



Physical Progress of Railway Embankments

- Dynamo
  - Typical section
- Revit
  - Elevation blocks
  - Cross-section blocks
  - NWC Export



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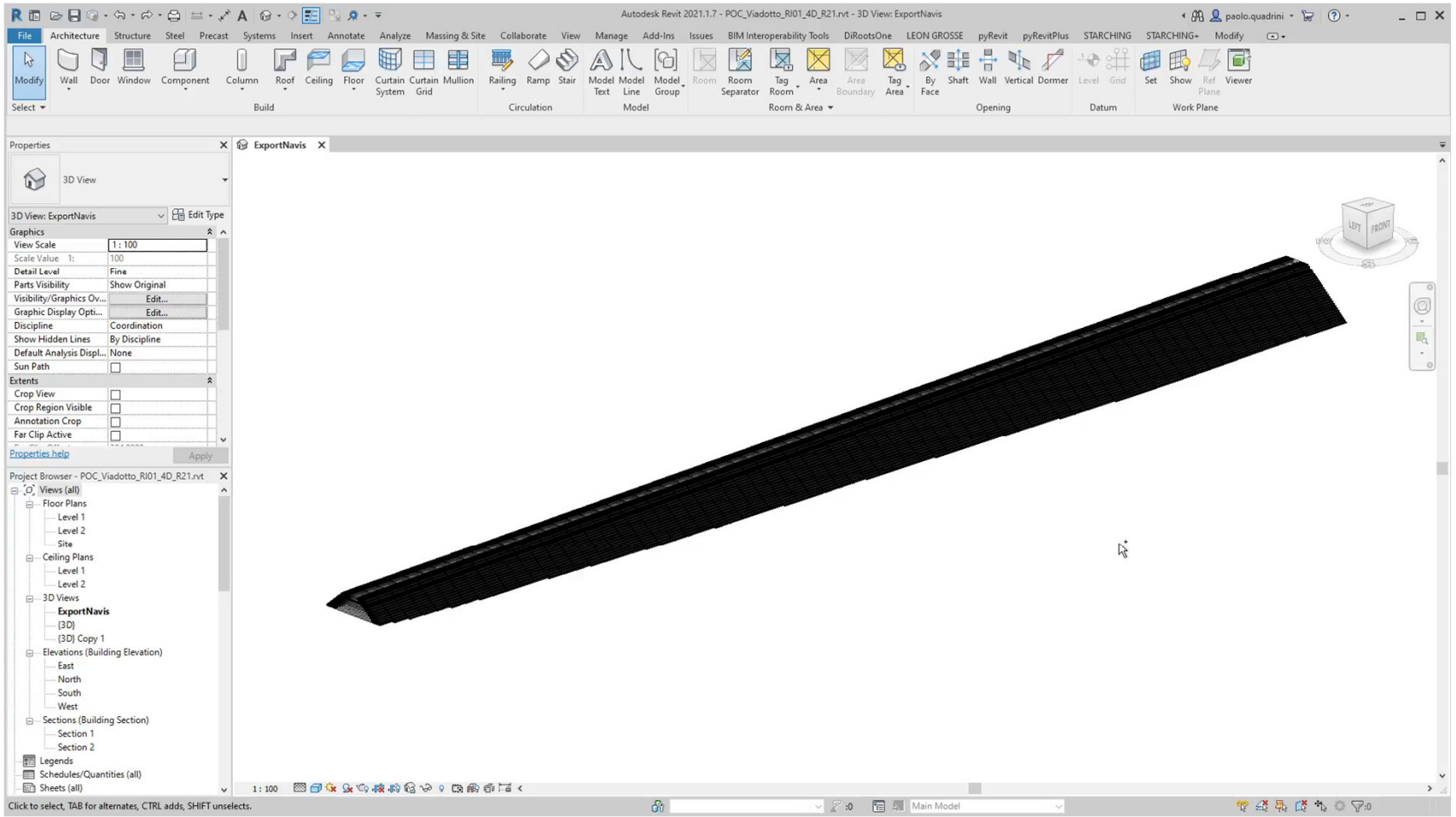
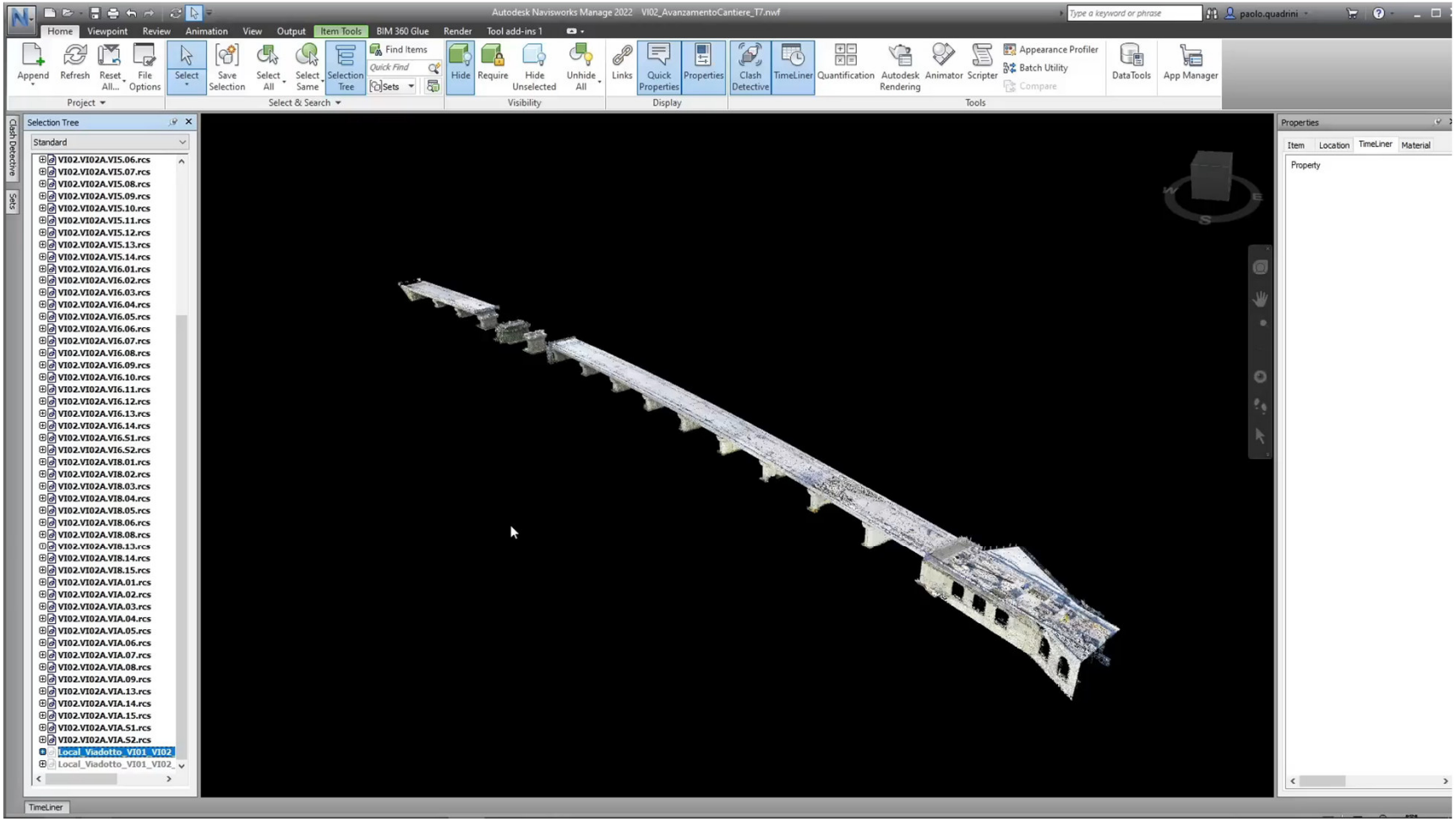


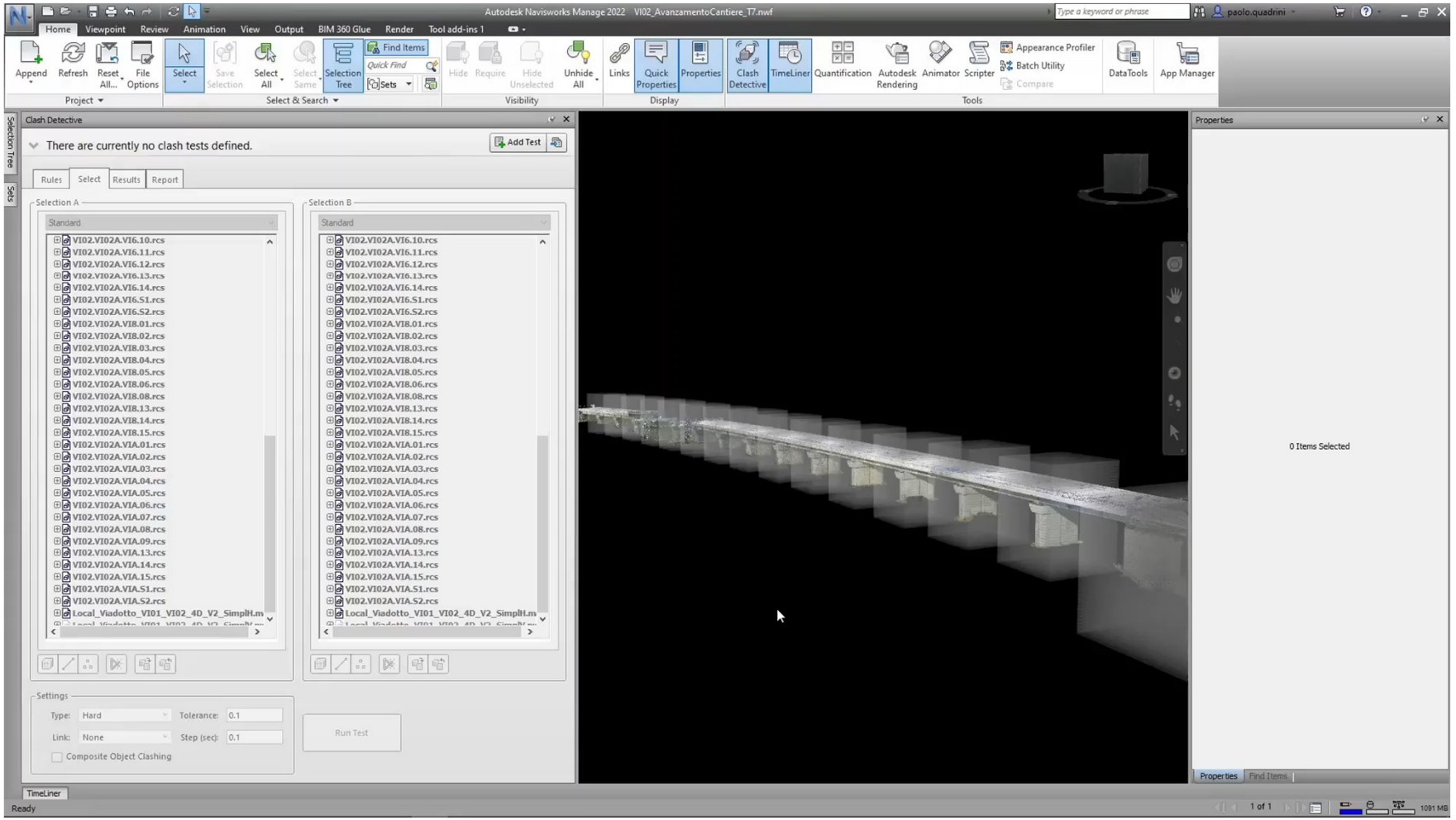
Clash detection - Navisworks

- Import
  - Point clouds
  - Revit Model
- Clash Matrix



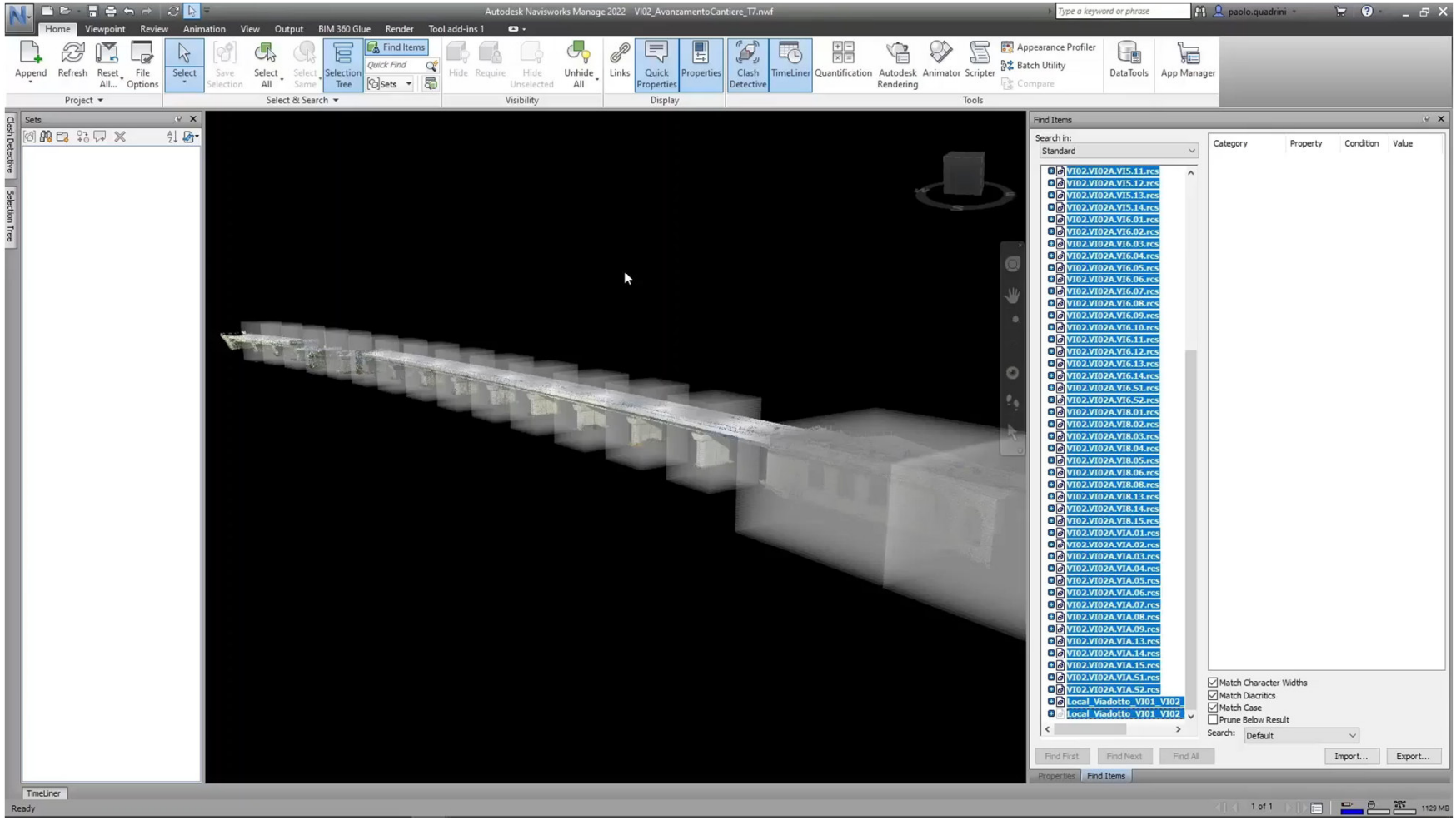
Clash detection - Navisworks

- Clash Matrix
  - Clash Tests
  - Revit Model
  - Clash Matrix
  - XML Export



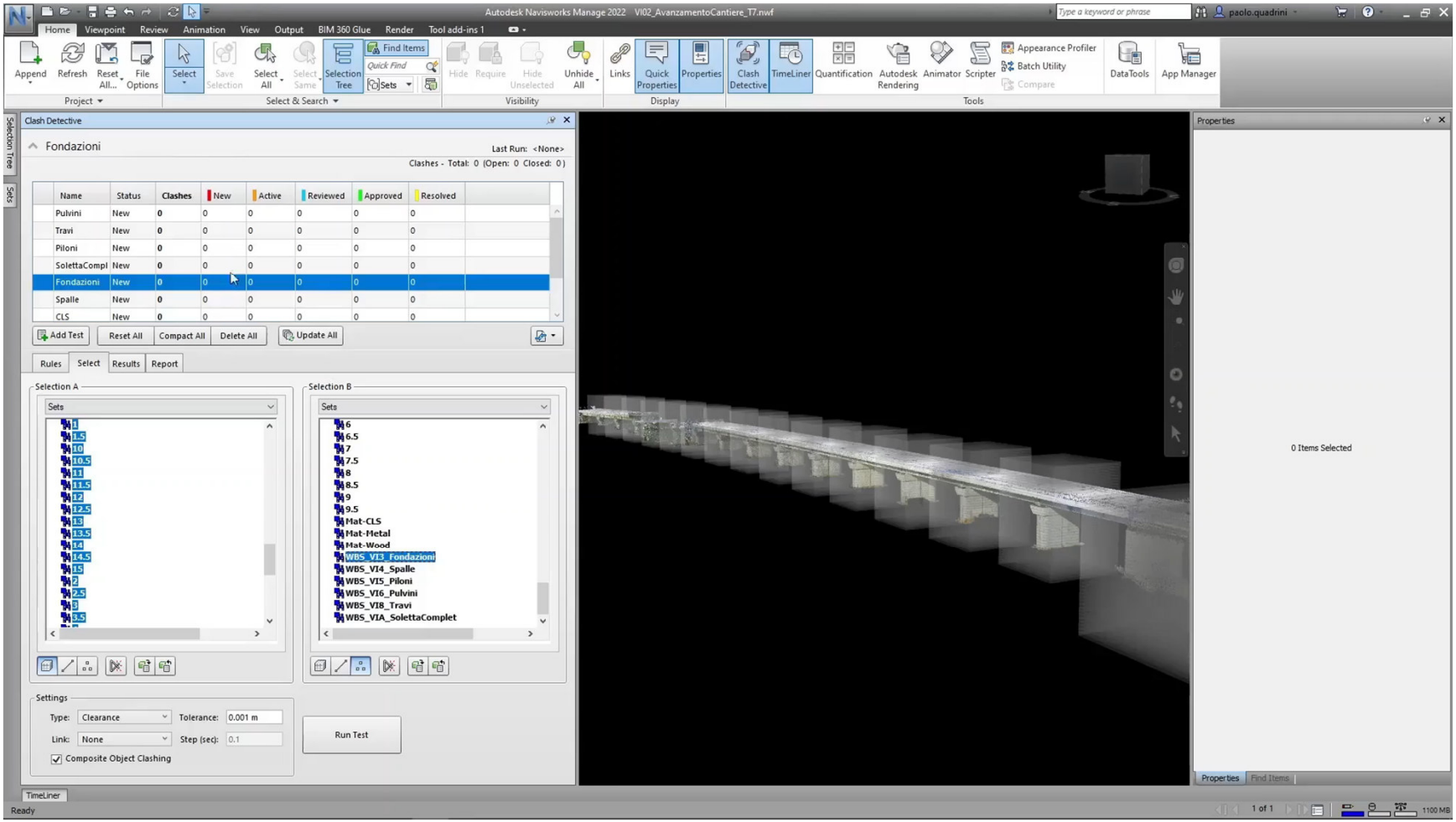
Clash detection - Navisworks

- Clash Matrix
  - Search sets
  - Clash test



Clash detection - Navisworks

- Clash Matrix
  - Results analysis
  - Report export



Physical Progress of Viaducts – SIL

- Document to record the progress of the works on site
- Document needed to calculate the amount of work must pay
- The procedures were slow and inaccurate

Direzione Lavori — ITALFERR

LAVORI DI REALIZZAZIONE DELLA LINEA FERROVIARIA NAPOLI-BARI
- TRATTA CANCELLO FRASSO TRA LE PK.0+000 E PK.16+500 E
LA VARIANTE ALLA LINEA ROMA-NAPOLI VIA CASSINO TRA LE PK.0+000 E PK.2+842
- INTERCONNESSIONE SU LINEA STORICA ROMA-NAPOLI VIA CASSINO

Appalto — CONSORZIO CFT — PIZZAROTTI — Ghella — ITINERA

SCHEDA DI RILEVAZIONE

Opera Principale (Liv.7) : VI01 — Variante LS RM-NA (Via Cassino) - Viadotto ferroviario dal km 1+031,724 al km 1+831,922

Commessa IF1K.1R01.A01 - Convenzione n.06/2017 del 22/12/2017 di rubrica RFI S.p.A.

Tratto d'opera (Liv.8) : VI01A — VI01 - BB01B - Variante LS RM-NA (Via Cassino) - Viadotto ferroviario Struttura "ad archi"

Progr. :

Lavori a corpo

Revisione N. / data .

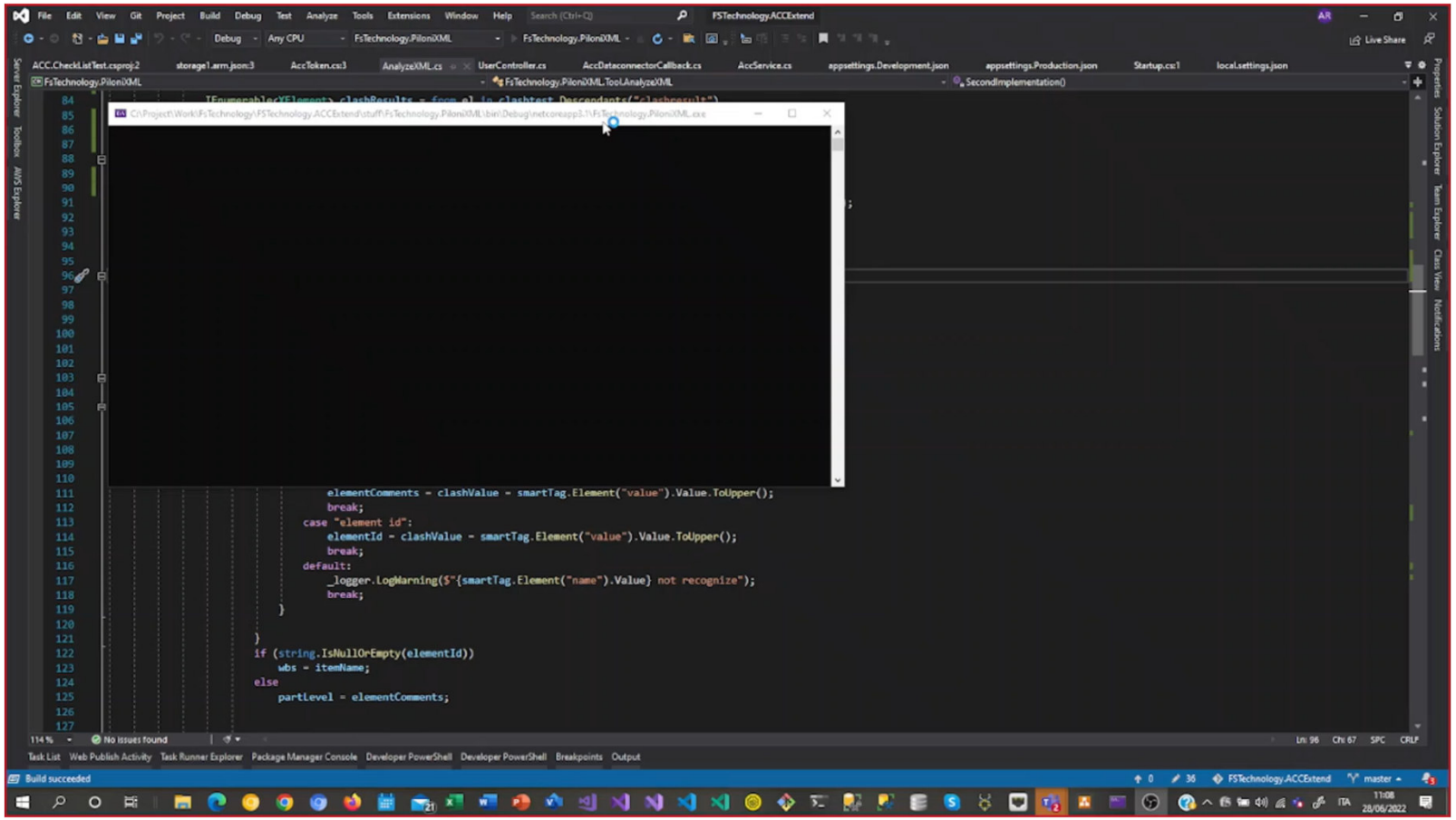
Scheda rilevaz. N. :

Data di rilevazione : **SIL 28 Luglio 2021**

P.do (Liv.9)	Parti d'opera	Data Inizio :	Data Fine :	incid. %	Dimensione Elemento	METAL	WOOD	CLS	ALERT	quantità progetto	U.M.	S.I.L. Q.precedente	S.I.L. Produz. precedente %	S.I.L. Q.Mese	S.I.L. Produz. Nel Periodo %	S.I.L. Q.progressivo	S.I.L. Produz. progressiva %	S.A.L. Q.precedente	S.A.L. Produz. precedente %	S.A.L. Q.Mese	S.A.L. Produz. Nel Periodo %	S.A.L. Q.progressivo	S.A.L. Produz. progressiva %	Osservazioni : note , N.C.
VI3	**Fondazioni**											28		28	**ALERT**									
1	VI01.VI01A.VI3.01			3,45	1,50	1,5		1,5	1						ALERT									
2	VI01.VI01A.VI3.02			3,45	1,50	1		1	1			1,0000		1,0000	ALERT									
3	VI01.VI01A.VI3.03			3,45	1,50	1,5		1,5	1			1,0000		1,0000	ALERT									
4	VI01.VI01A.VI3.04			3,45	1,50	2		2	1			1,0000		1,0000	ALERT									
5	VI01.VI01A.VI3.05			3,45	1,50	1		1	1			1,0000		1,0000	ALERT									
6	VI01.VI01A.VI3.06			3,45	1,50	2,5		2,5	1			1,0000		1,0000	ALERT									
7	VI01.VI01A.VI3.07			3,45	1,50			2	2			1,0000		1,0000	ALERT									
8	VI01.VI01A.VI3.08			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
9	VI01.VI01A.VI3.09			3,45	1,50			0,5				1,0000	82,67%	1,0000	82,67%		82,67%							
10	VI01.VI01A.VI3.10			3,45	1,50							1,0000	74,00%	1,0000	74,00%		74,00%							
11	VI01.VI01A.VI3.11			3,45	1,50			1				1,0000	91,33%	1,0000	91,33%		91,33%							
12	VI01.VI01A.VI3.12			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
13	VI01.VI01A.VI3.13			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
14	VI01.VI01A.VI3.14			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
15	VI01.VI01A.VI3.15			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
16	VI01.VI01A.VI3.16			3,45	1,50			2	2			1,0000		1,0000	ALERT									
17	VI01.VI01A.VI3.17			3,45	1,50			1,5				1,0000	100,00%	1,0000	100,00%		100,00%							
18	VI01.VI01A.VI3.18			3,45	1,50			2	2			1,0000		1,0000	ALERT									
19	VI01.VI01A.VI3.19			3,45	1,50			2	2			1,0000		1,0000	ALERT									
20	VI01.VI01A.VI3.20			3,45	1,50			2	2			1,0000		1,0000	ALERT									
21	VI01.VI01A.VI3.21			3,45	1,50			2,5	2			1,0000		1,0000	ALERT									
22	VI01.VI01A.VI3.22			3,45	1,50			2	2			1,0000		1,0000	ALERT									
23	VI01.VI01A.VI3.23			3,45	1,50	0,5		1,5	1			1,0000		1,0000	ALERT									
24	VI01.VI01A.VI3.24			3,45	1,50	0,5		1	1			1,0000		1,0000	ALERT									
25	VI01.VI01A.VI3.25			3,45	1,50	1		1	1			1,0000		1,0000	ALERT									

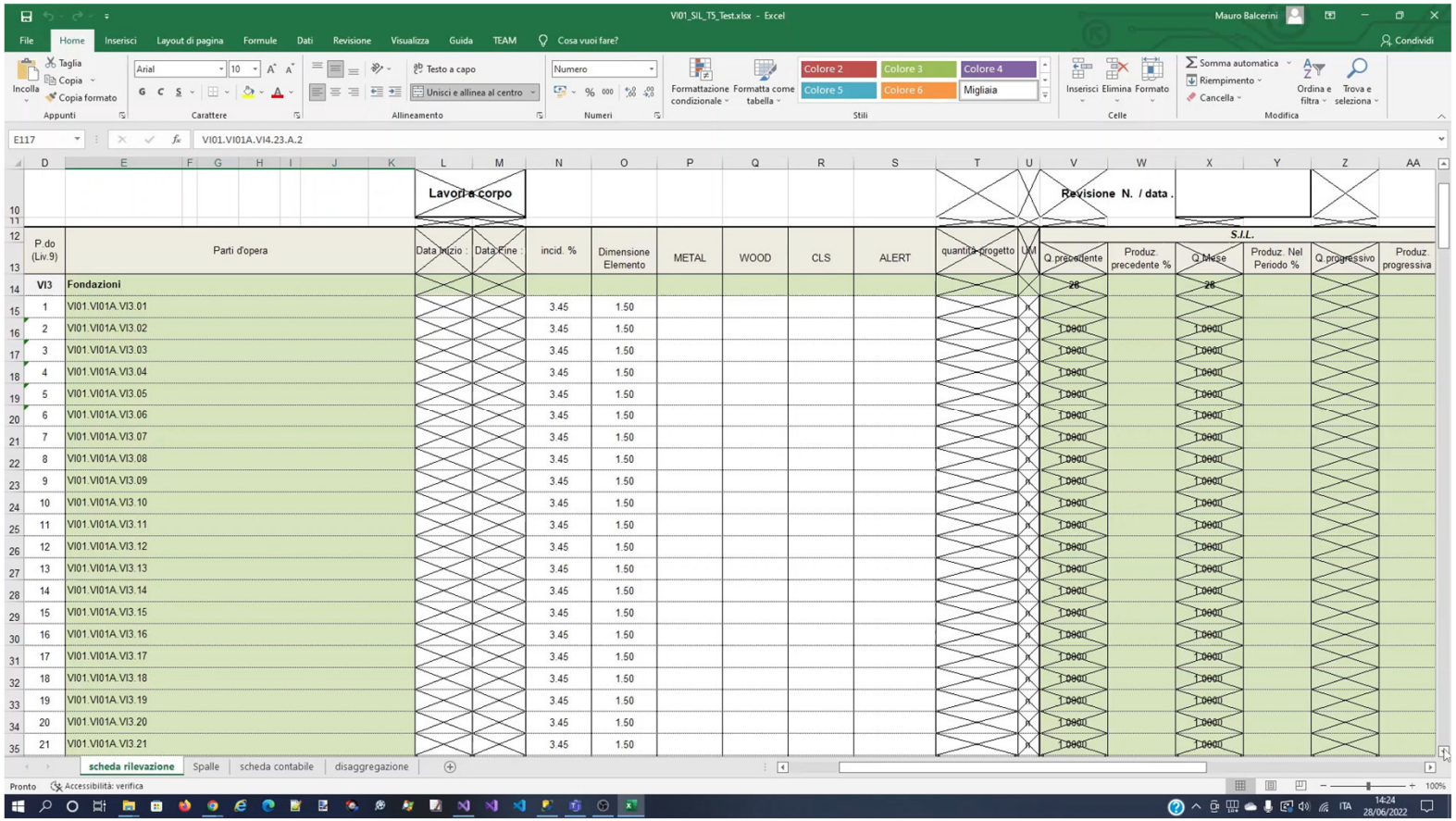
Clash detection report post-processing

- Group the clashes in the Navisworks export
- Remove duplicate clashes
- Define the elevation for each material



Automated compilation of SIL

- Automated compilation
- Calculation of the percentages of each element and material built
- Adding alerts to indicate possible anomalies



Lavori a corpo

Revisione N. / data .

S.I.L.

P.do (Liv.9)	Parti d'opera	Data Inizio	Data Fine	incid. %	Dimensione Elemento	METAL	WOOD	CLS	ALERT	quantità progetto	UM	Q. precedente	Produz. precedente %	Q. Mese	Produz. Nel Periodo %	Q. progressivo	Produz. progressiva
VI3	Fondazioni											28		28			
1	VI01.VI01A.VI3.01			3.45	1.50							1.0000		1.0000			
2	VI01.VI01A.VI3.02			3.45	1.50							1.0000		1.0000			
3	VI01.VI01A.VI3.03			3.45	1.50							1.0000		1.0000			
4	VI01.VI01A.VI3.04			3.45	1.50							1.0000		1.0000			
5	VI01.VI01A.VI3.05			3.45	1.50							1.0000		1.0000			
6	VI01.VI01A.VI3.06			3.45	1.50							1.0000		1.0000			
7	VI01.VI01A.VI3.07			3.45	1.50							1.0000		1.0000			
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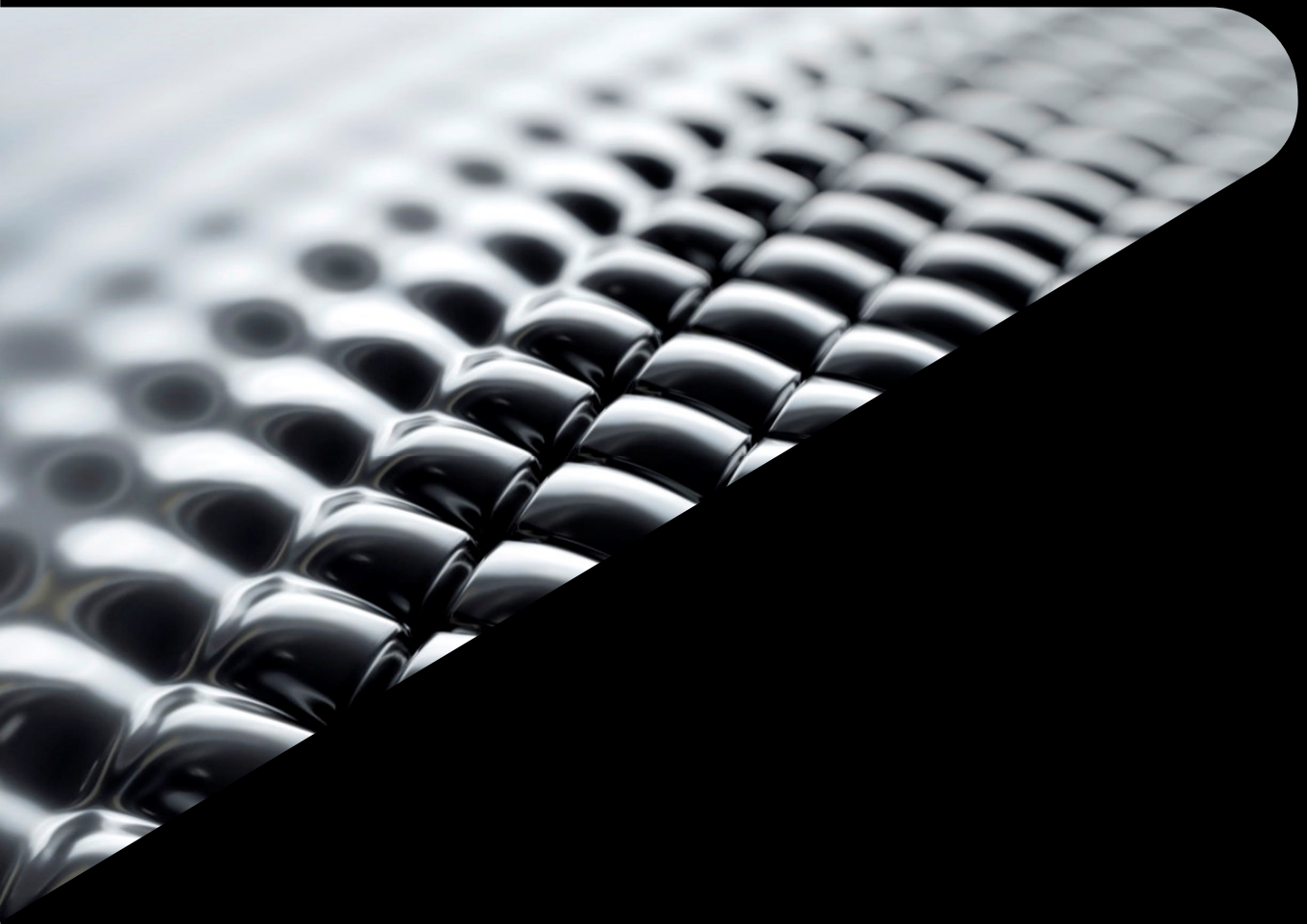
10	VI01.VI01A.VI3.10			3.45	1.50							1.0000		1.0000			
11	VI01.VI01A.VI3.11			3.45	1.50							1.0000		1.0000			
12	VI01.VI01A.VI3.12			3.45	1.50							1.0000		1.0000			
13	VI01.VI01A.VI3.13			3.45	1.50							1.0000		1.0000			
14	VI01.VI01A.VI3.14			3.45	1.50							1.0000		1.0000			
15	VI01.VI01A.VI3.15			3.45	1.50							1.0000		1.0000			
16	VI01.VI01A.VI3.16			3.45	1.50							1.0000		1.0000			
17	VI01.VI01A.VI3.17			3.45	1.50							1.0000		1.0000			
18	VI01.VI01A.VI3.18			3.45	1.50							1.0000		1.0000			
19	VI01.VI01A.VI3.19			3.45	1.50							1.0000		1.0000			
20	VI01.VI01A.VI3.20			3.45	1.50							1.0000		1.0000			
21	VI01.VI01A.VI3.21			3.45	1.50							1.0000		1.0000			



Conclusions

Virtual construction site management

How to achieve up to 40% in overall time reduction

Overall Site Supervision Time

Virtual construction site management

How to achieve up to 40% in overall time reduction

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Virtual construction site management

How to achieve up to 40% in overall time reduction

Overall Site Supervision Time

Cut&Fill Volumes Accuracy

Physical Progress Monitoring Time

Virtual construction site management

How to achieve up to 40% in overall time reduction

Overall Site Supervision Time

Cut&Fill Volumes Accuracy

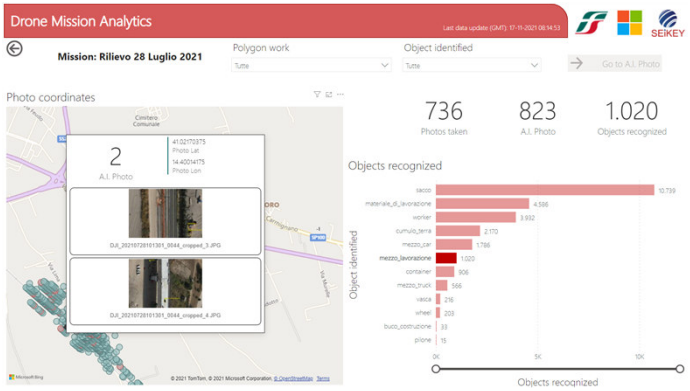
Physical Progress Monitoring Time

Data Utilization Efficiency

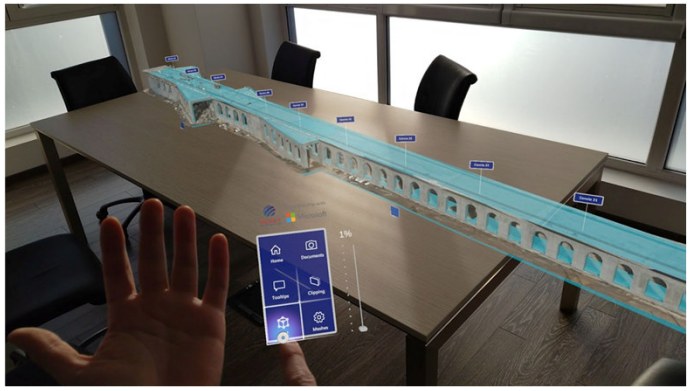
Virtual construction site management

Next steps

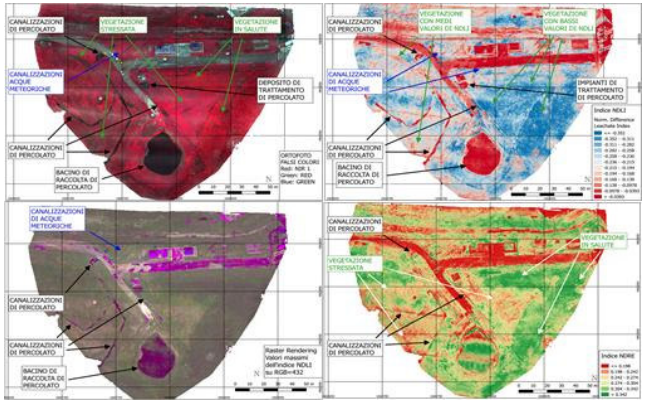
Artificial Intelligence



AR - VR



Environmental Control




FERROVIE
DELLO STATO
ITALIANE