World Tunnel Congress & Exhibition

WTC 2019

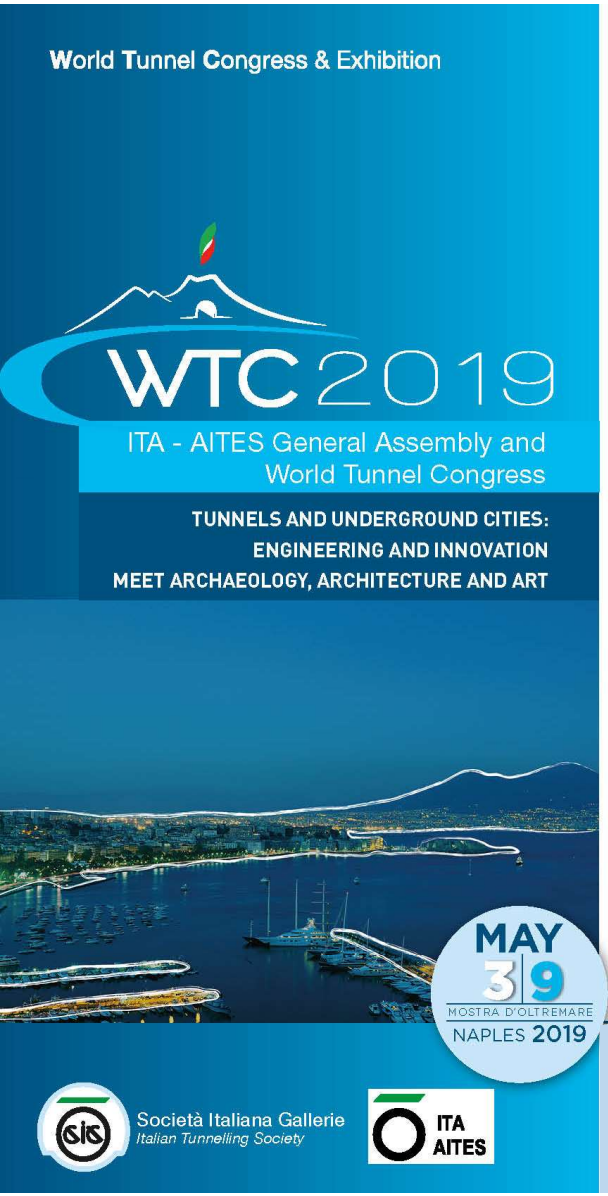
ITA - AITES General Assembly and World Tunnel Congress

MAY 3|9
MOSTRA D'OLTREMARE
NAPLES 2019

TUNNELS AND UNDERGROUND CITIES: ENGINEERING AND INNOVATIONMEET ARCHAEOLOGY, ARCHITECTURE AND ART

Società Italiana Gallerie
Italian Tunnelling Society

ITA AITES



Innovation in underground engineering, materials and equipment

Integrated functional metro station design using BIM tools

A. Bolzonello, C. Pallaria, D. Vercellino

Geodata Engineering S.p.A., Turin, Italy

Presenting author: Christian Pallaria

GEODATA
UNDERGROUND SOLUTIONS

I'm here for…

1. Presenting our **Istanbul Metro Line project** developed with a "full BIM approach" using **computational design tools**

2. A quick presentation of **our last experiences in BIM for Tunneling**

Istanbul

- Istanbul is a megalopolis with **over than 14 million of inhabitants**, characterized by a mixture of historical and modern urbanization, often uncontrolled, and natural constraints.
- **The morphology of Istanbul**, heavily hilly and with the Bosphorus that separates the Eastern and Western sides, adds greater complexity to these challenges.
- Large investment plan that consists in building, by 2023 (**100th celebration of the founding of the Turkish Republic**), a new metropolitan railway network, **covering the metropolitan area of about 500 km**.

İSTANBUL
BÜYÜKŞEHİR
BELEDİYESİ

Railway Metro Lines in Istanbul

Within this ambitious investment plan, Geodata has been involved in the development of four subway projects

Metro Line	Lenght	Stations	Design Stage
Dudullu-Bostanci	14 Km	13	Final and Construction Design
Ümraniye-Ataşehir-Göztepe	13 Km	11	Final Design
Kirazli-Halkali	9,6 Km	9	Final and Construction Design
Gayrettepe – İstanbul Yeni Havalimani	37 Km	10	Detail design revision and Construction Design

All abovementioned projects have been done with a “full BIM approach”, from the alignment up to stations design, considering also temporary and permanent structures.

BEP and stakeholders cooperation

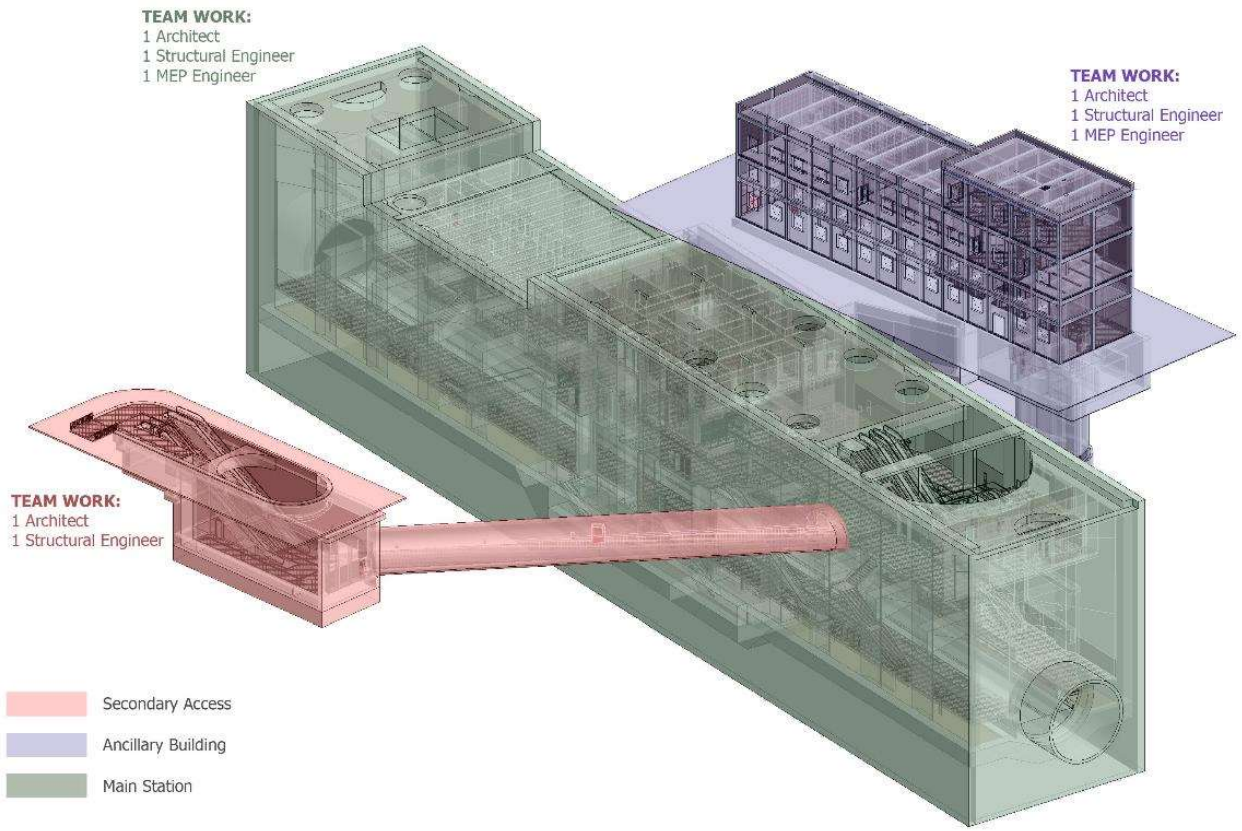
The BEP (BIM Execution Plan) defined the rules of how to use BIM in the entire project (within Geodata and with other stakeholders)

The main problem was that there was no a standard classifiers imposed from the Client. **There are no any recommendations, standards or guidelines for tunneling**.

The BEP defined also rules to generate a federated model, that consists of linking different disciplines, in particular:

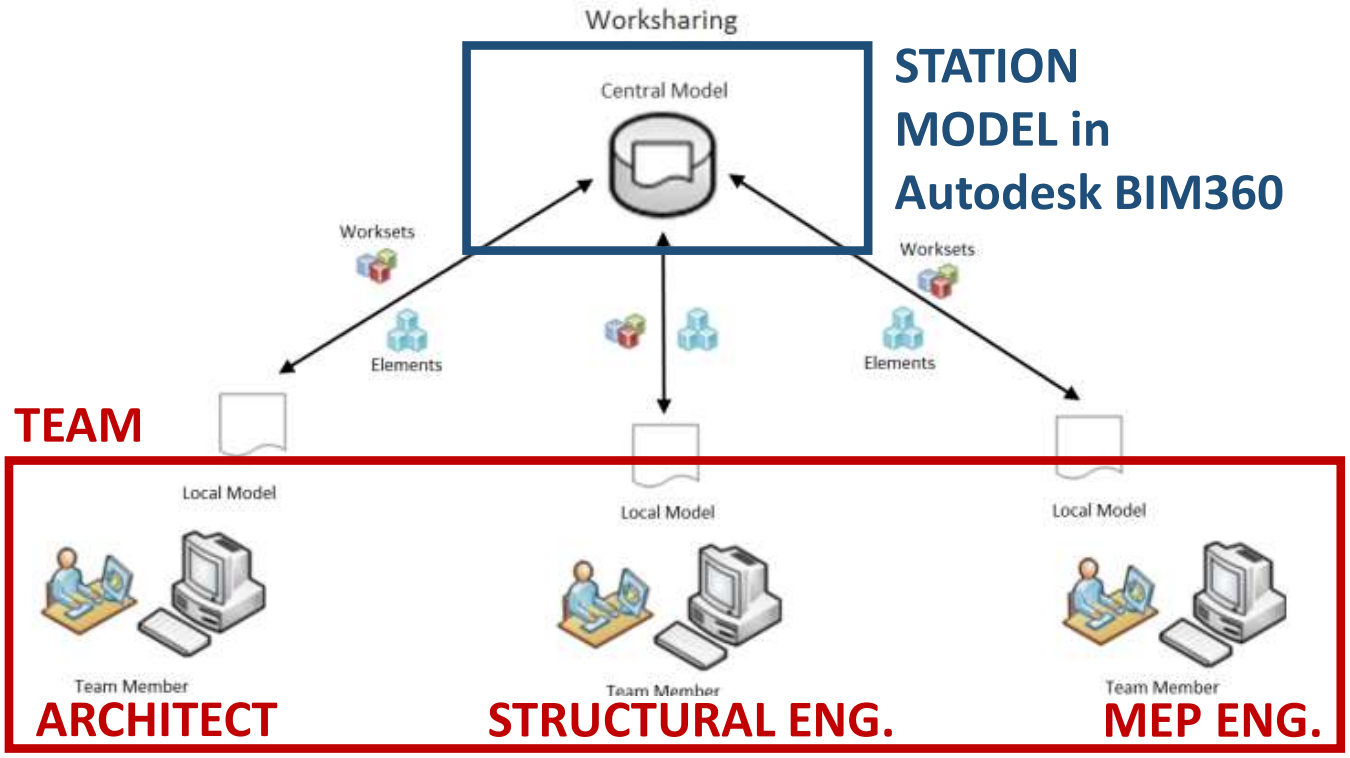
- **Functional/Architectural model**
- **Structural model**
- **MEP model**

Architectural and functional design



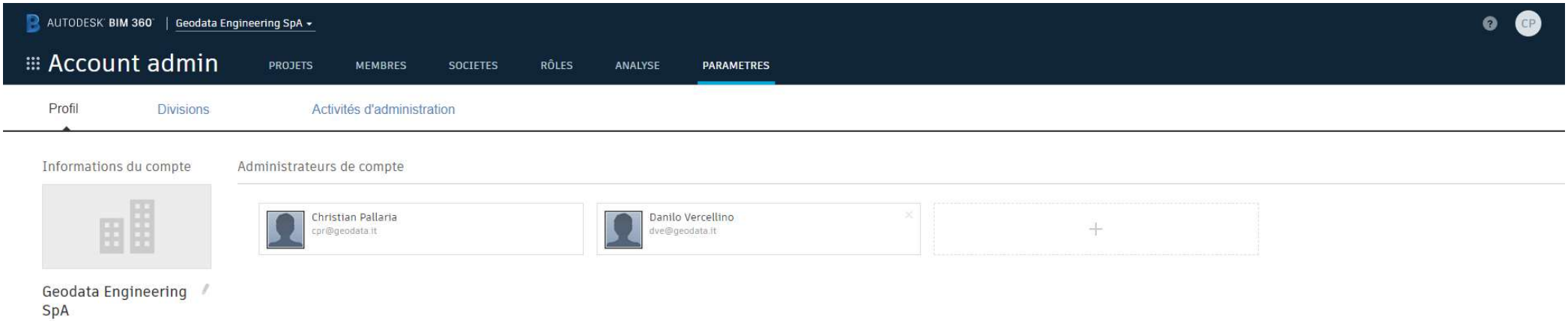
The use of the BIM approach has improved for the design management both within Geodata and towards other Stakeholders. In particularly, it has been extremely useful for **sharing the same model simultaneously with structural, architectural and MEP designers**.

Interaction and interface in a teamwork



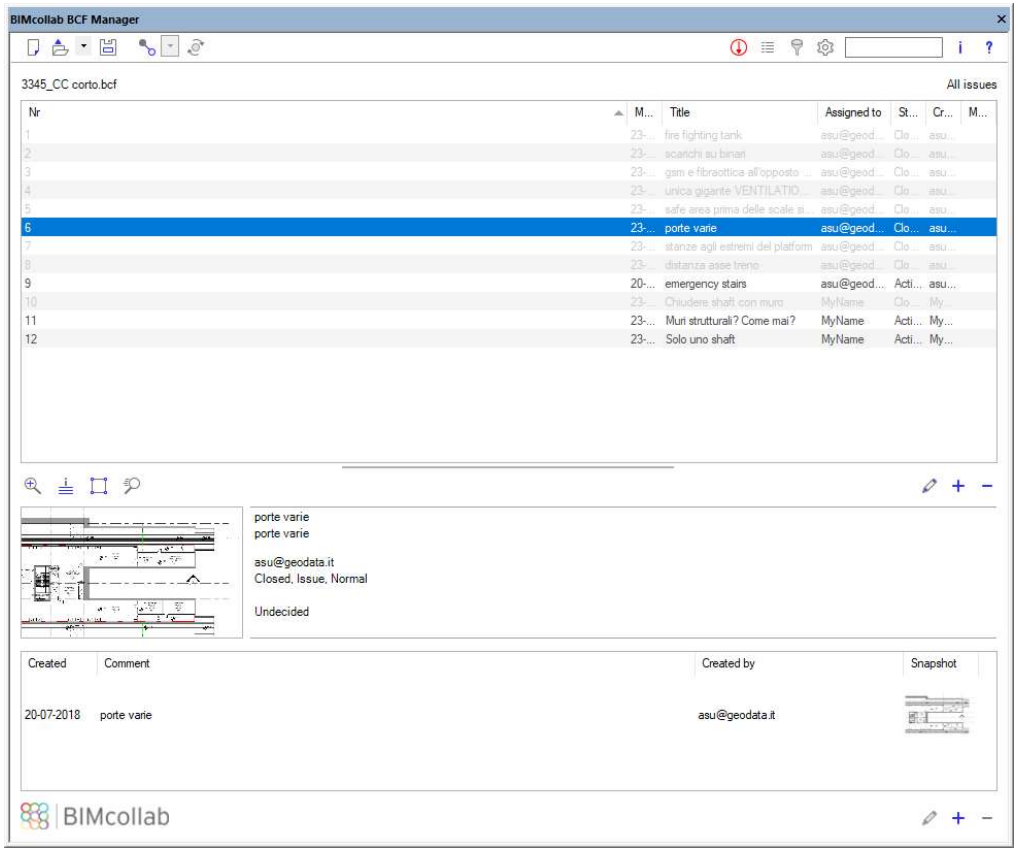
The **interaction and the interface with all the other related disciplines, structural design, MEP design, architectural finishes, is a must**. The greater the interaction between the disciplines is and the minors the negative impacts are during the construction phase.

Autodesk BIM360 for stakeholder collaboration



Autodesk BIM360 was used at the construction level, in order to give a full access of the design documentation to all stakeholders, with **different access rules** according to the user. Everyone was able to insert comments, even uploading images **directly from the station sites**. All this allowed a **simultaneous coordination between stakeholders**, especially between the Construction Supervision, the Contractor and the designers.

BCF (BIM Collaboration Format)



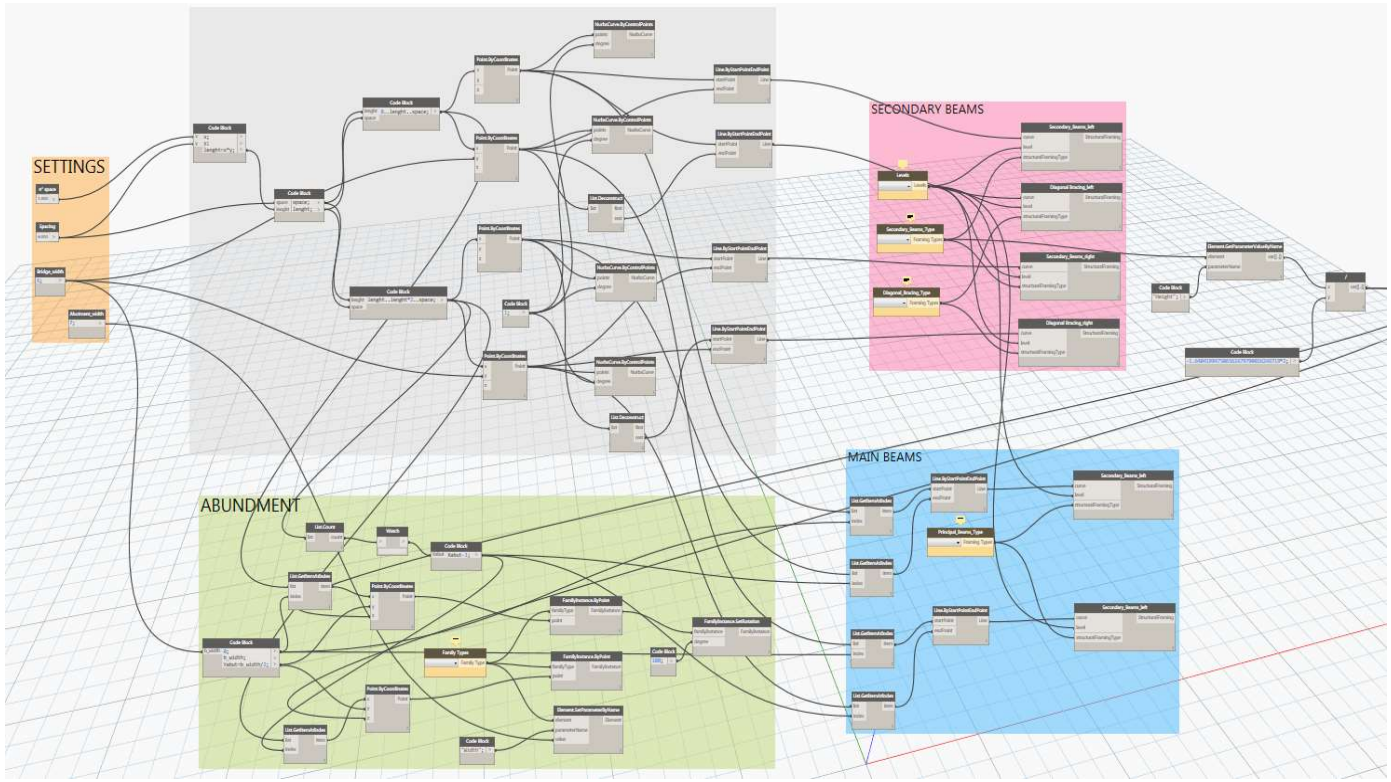
For the design phases, the BCF format was used to check errors, to make “issues and changes report” and to keep track of all the changes requested, made or rejected.

Every Friday a **general coordination meeting** was held between the various disciplines and **a specific report of issues and changes** in BCF format was re-issued.

Dynamo

Computational Design

Computational design consists of applying computational strategies to conventional design processes.

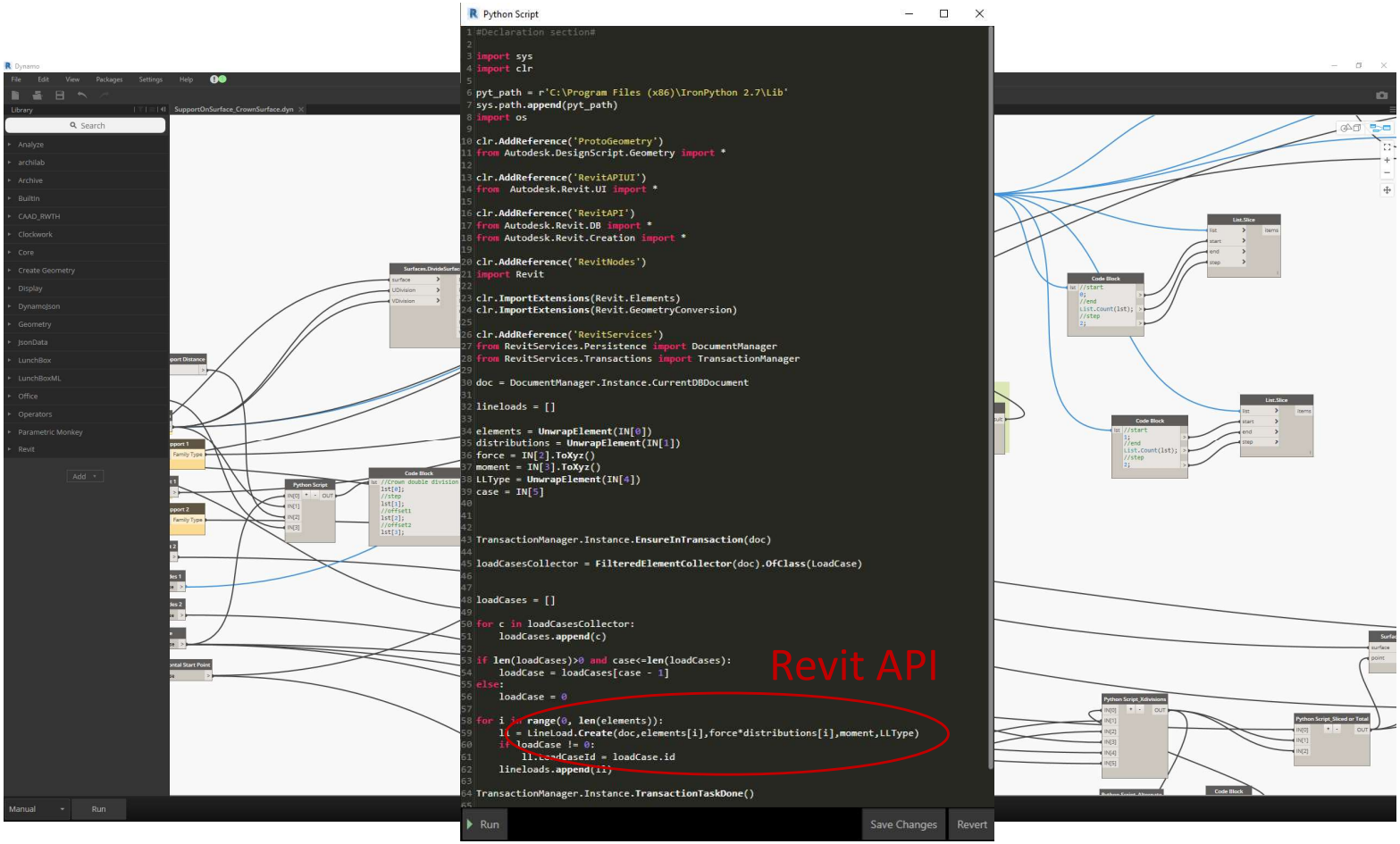


Dynamo is a visual programming language. It consists of standard nodes that allow to do many operations.

When the nodes doesn't do what you need, you have to program your custom node using Python programme language

Dynamo

Computational Design



Python is a simple program language object oriented used in many other contexts other than Dynamo.

It is useful also for machine learning simulations.

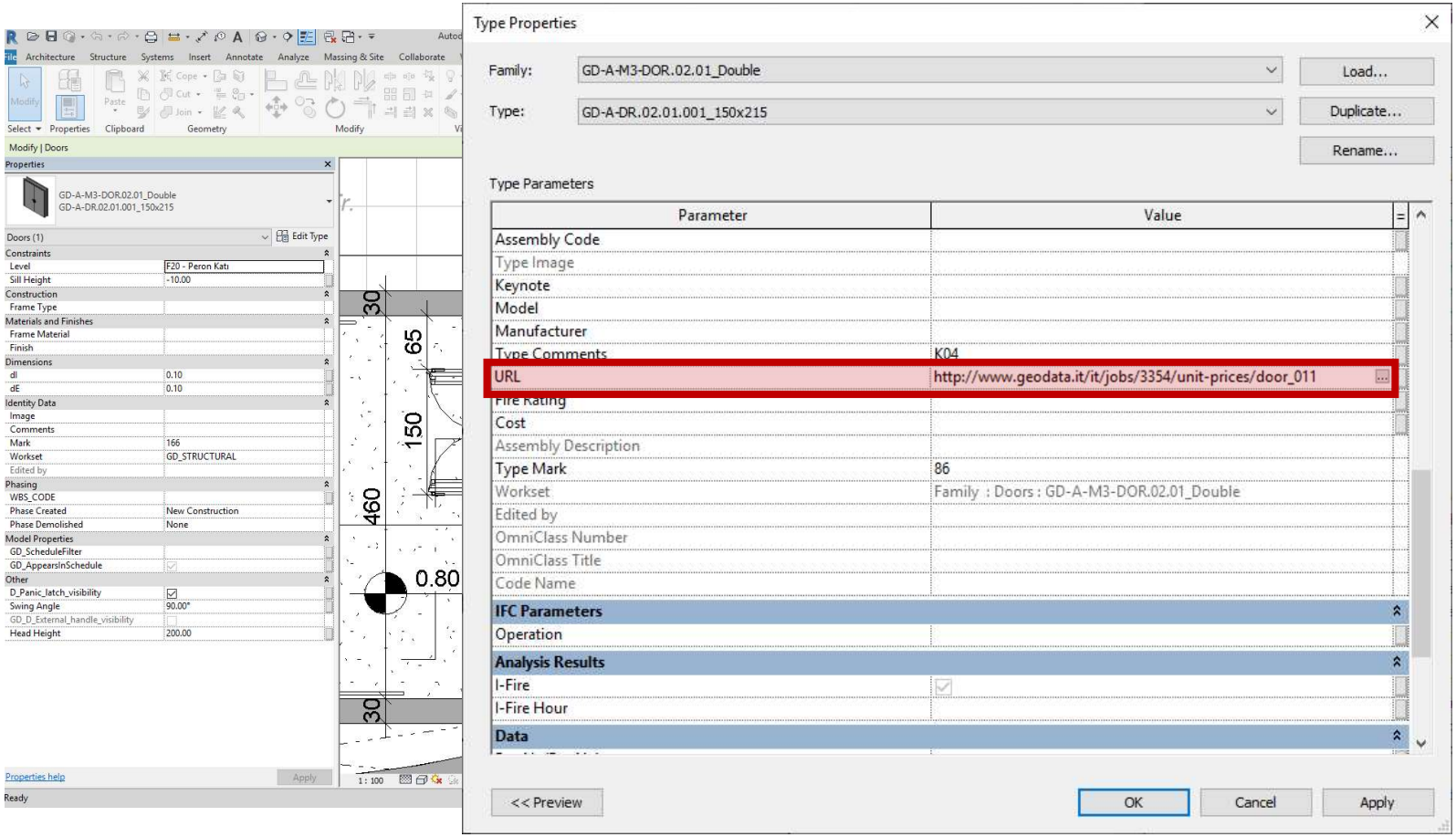
Dynamo

Application of Computational Design

Automated workflow for:

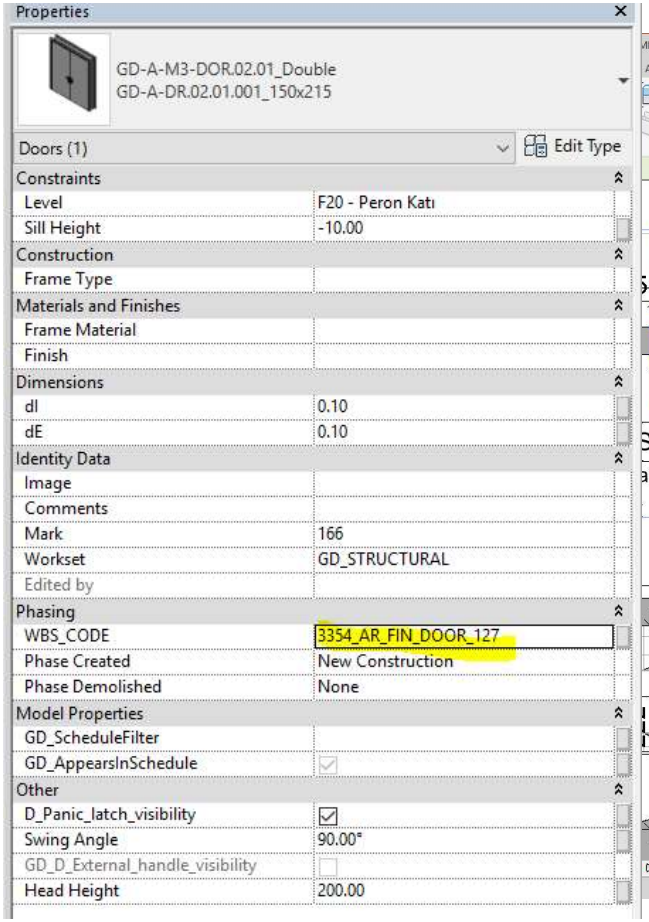
- filling **title blocks** by reading the parameters from the processed list of drawings
- filling **stations room names** according to the coding for each room
- **numbering model elements** (rooms, walls, pillars, slabs, etc ...)
- **writing specific parameters** extrapolated from external database
- **modelling TBM tunnels**
- **modelling NATM tunnels**
- **modelling excavation supports**
- Automated **design of TBM segments** by using a specific tool developed for **Inventor**

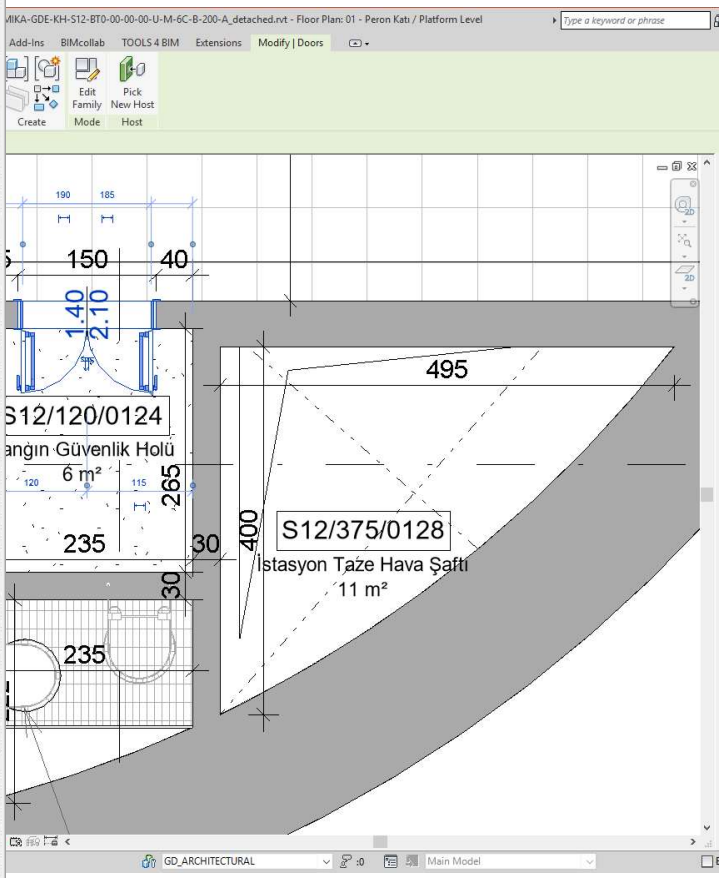
Architectural and functional design



By specific parameters applied to families and materials, it was possible to **link Revit's internal materials to the technical specifications and unit prices**, in accordance with the local legislation, through an exchange of information with the company, which periodically updated the BoQ.

Architectural and functional design

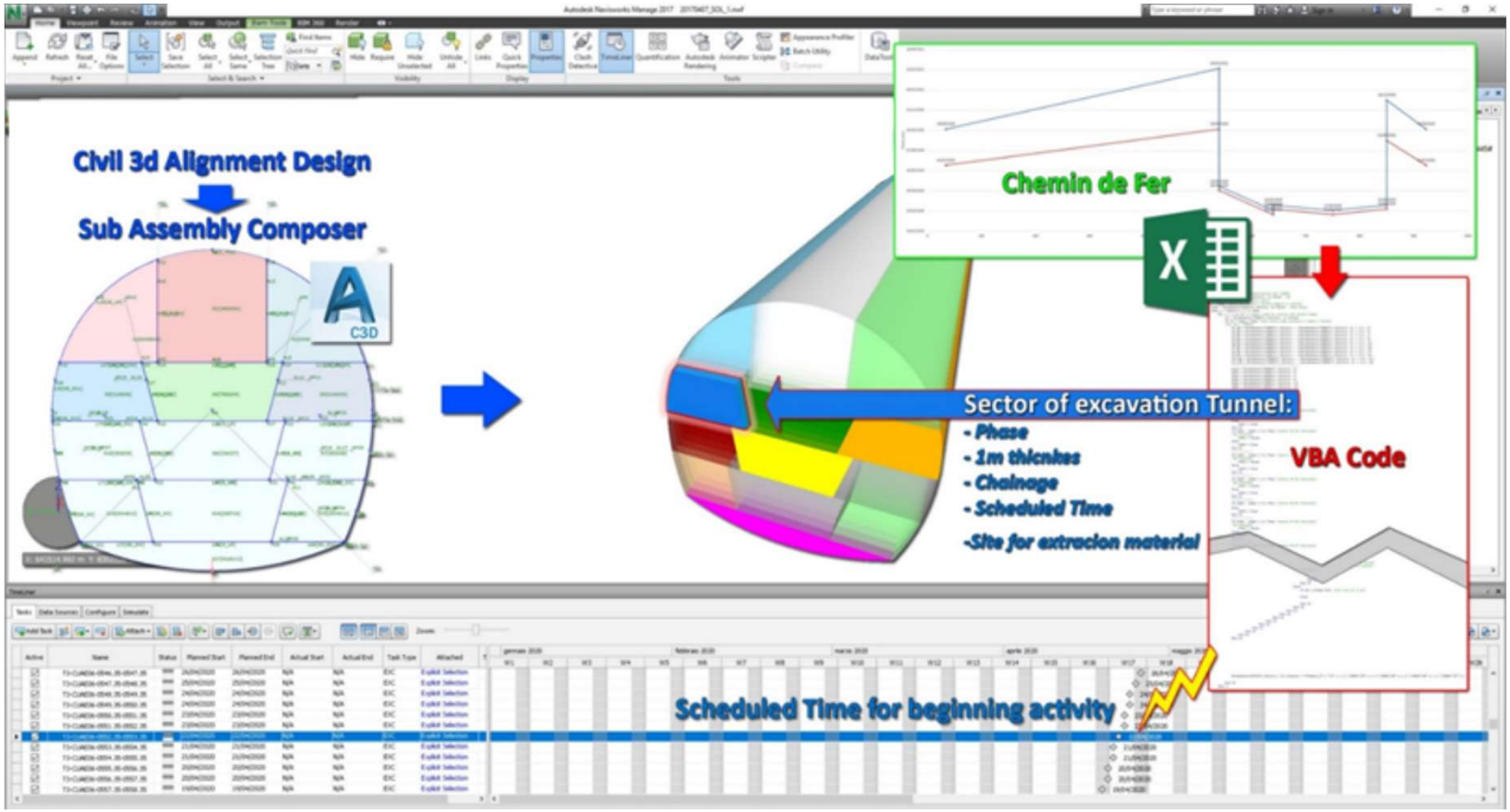




This procedure of parameterization and population of the families has been adopted also for writing the **WBS codes useful for the management of 4D and 5D**, developed in a post-modelling phase using **Navisworks**

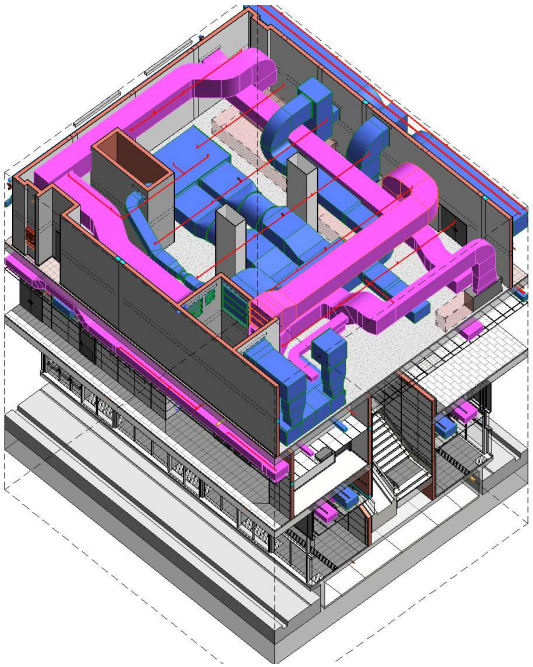
AUTODESK
REVIT

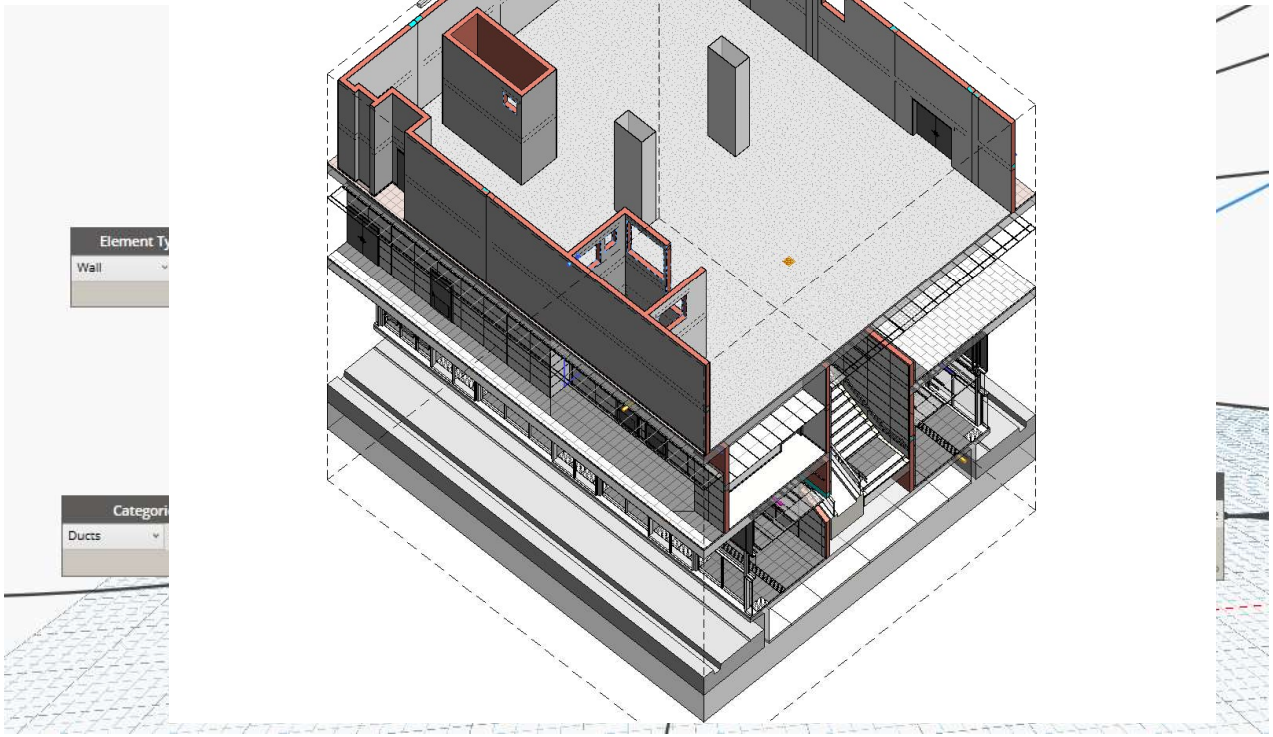
4D and 5D simulations



Revit MEP, clash detection and openings

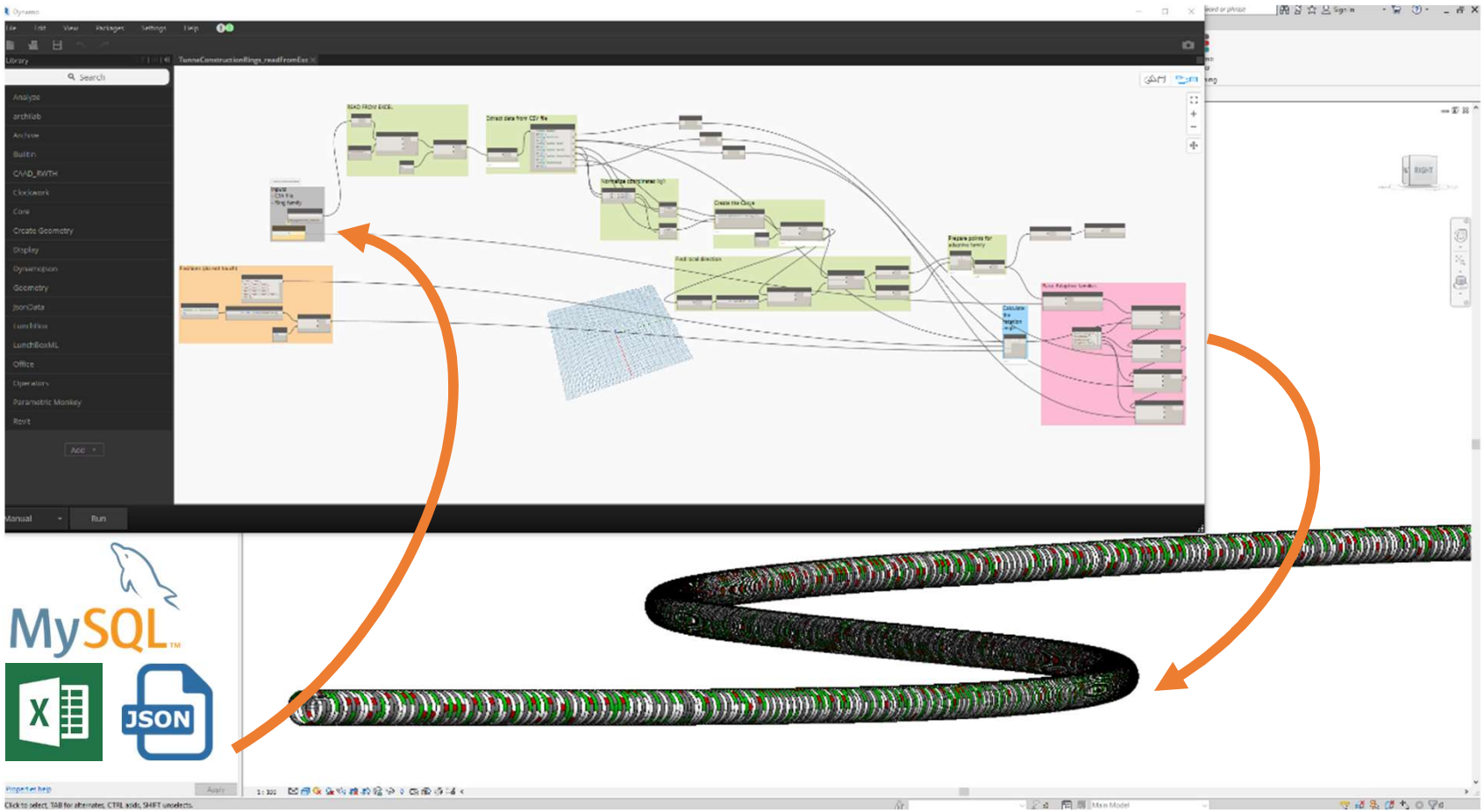
Use of specific Add In for realizing cut
Add In didn’t work properly we also u
opening





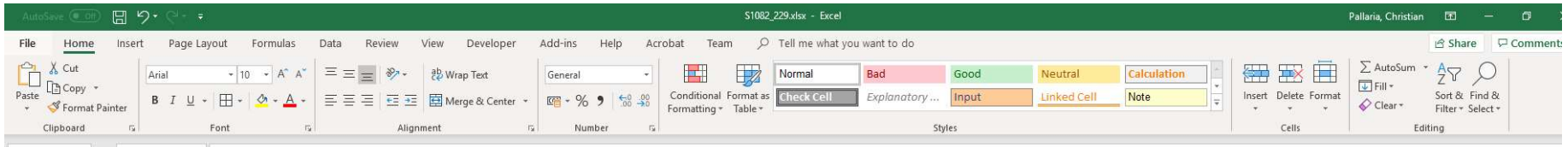
Dynamo

Modelling TBM tunnels



Dynamo

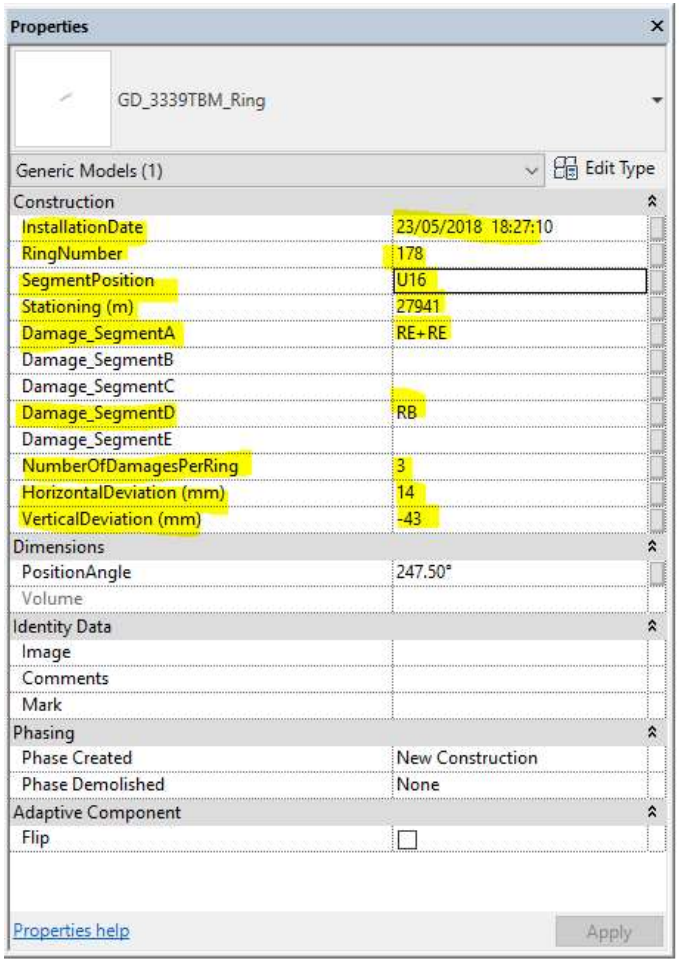
Modelling TBM tunnels

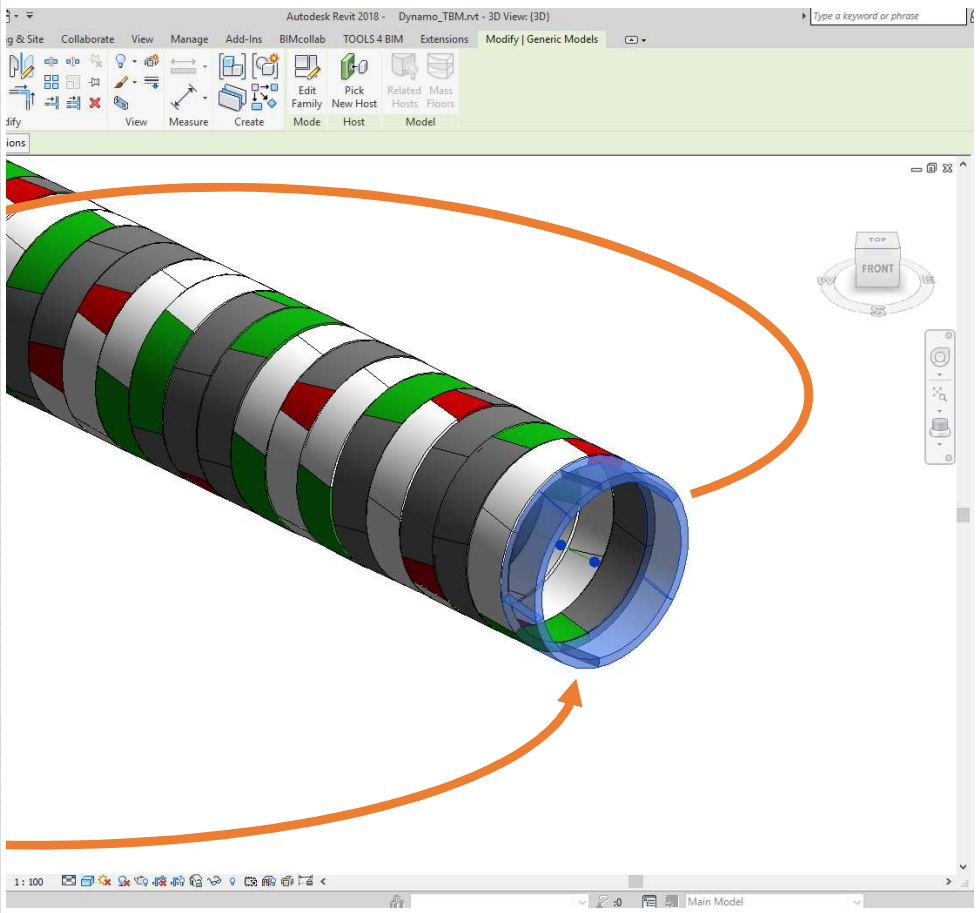


Ring Number	Date and time (Ring selection)	Ring	Ring center EAST value [m]	Ring center NORTH value [m]	Ring center HEIGHT value [m]	Ring center Stationing [m]
1	23.05.2018 18:27:10	U13	400217,058	4568159,562	51,136	27941,38
2	24.05.2018 07:00:38	U08	400218,015	4568158,407	51,147	27939,88
3	24.05.2018 15:09:40	U13	400219,004	4568157,270	51,144	27938,37
4	24.05.2018 22:14:33	U15	400220,011	4568156,157	51,185	27936,87
5	26.05.2018 15:53:50	U10	400221,019	4568155,044	51,181	27935,37
6	26.05.2018 23:44:07	U05	400222,031	4568153,936	51,197	27933,87
7	27.05.2018 06:28:25	U07	400223,026	4568152,809	51,206	27932,37
8	28.05.2018 16:17:58	U12	400224,026	4568151,695	51,200	27930,87
9	29.05.2018 03:52:33	U04	400225,026	4568150,579	51,204	27929,37
10	29.05.2018 11:37:20	U09	400226,022	4568149,456	51,188	27927,87
11	29.05.2018 18:07:55	U01	400227,012	4568148,326	51,178	27926,37
25	24	01.06.2018 22:27:04	U01	400239,920	4568133,675	51,182	27906,84	36,04	5	2
26	25	02.06.2018 02:53:39	U09	400240,913	4568132,553	51,186	27905,35	37,53	4	5
27	26	02.06.2018 06:28:20	U14	400241,858	4568131,384	51,201	27903,84	39,04	68	20
28	27	02.06.2018 11:01:49	U06	400242,887	4568130,287	51,180	27902,34	40,54	23	-2
29	28	02.06.2018 14:57:09	U01	400243,863	4568129,142	51,187	27900,83	42,05	49	4
30	29	03.06.2018 23:04:20	U09	400244,832	4568128,035	51,191	27899,36	43,52	56	7
31	30	04.06.2018 02:01:08	U14	400245,855	4568126,897	51,186	27897,83	45,05	41	0
32	31	04.06.2018 05:31:47	U16	400246,835	4568125,812	51,199	27896,37	46,51	25	12
33	32	04.06.2018 09:45:40	U05	400247,870	4568124,667	51,210	27894,83	48,05	7	21
34	33	04.06.2018 13:34:03	U10	400248,870	4568123,547	51,212	27893,33	49,55	-2	21
35	34	04.06.2018 16:14:56	U08	400249,866	4568122,454	51,210	27891,85	51,03	-25	17

Dynamo

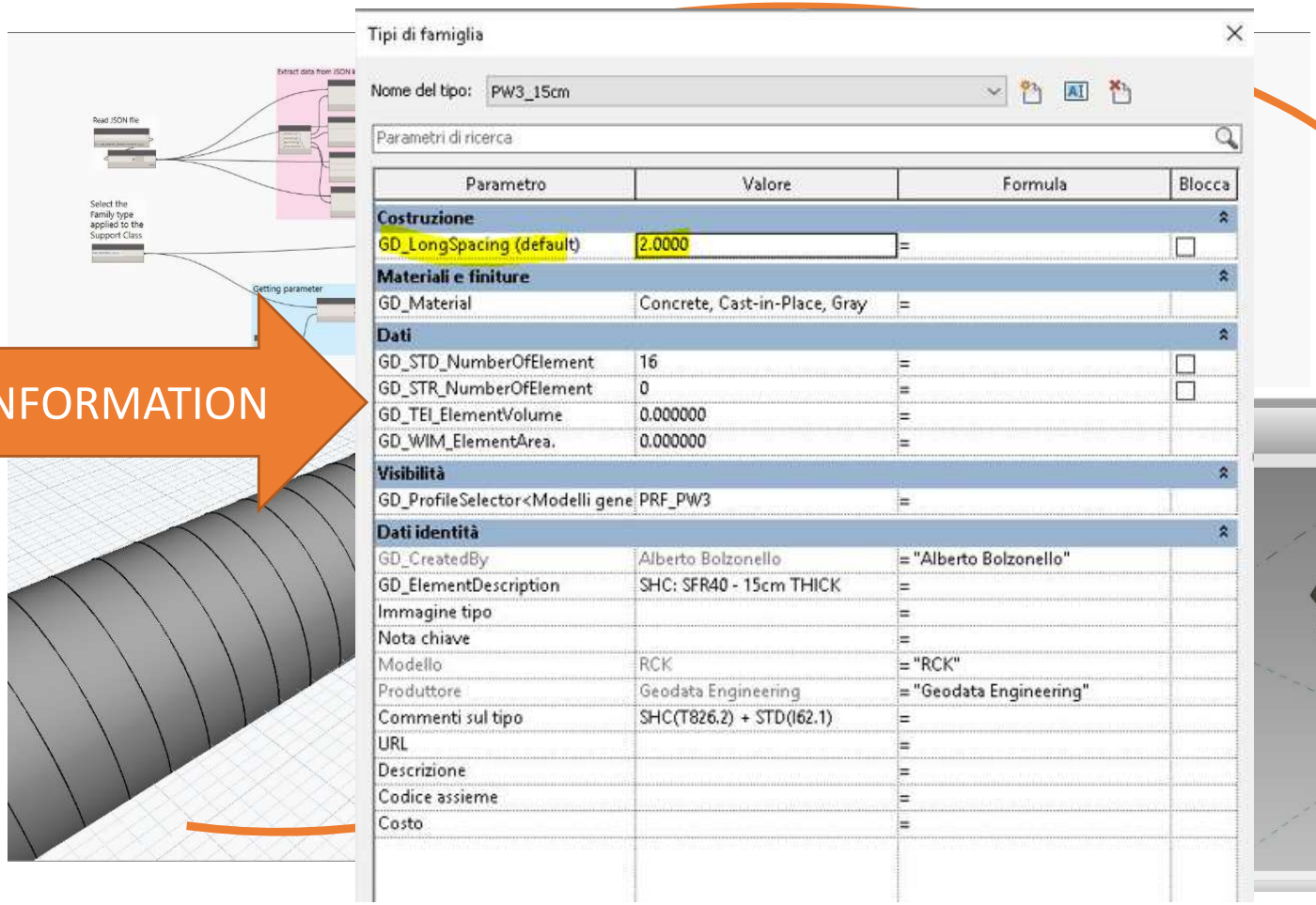
Modelling TBM tunnels



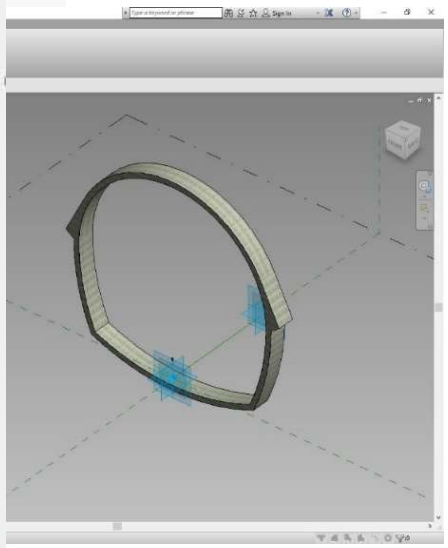


Dynamo

Modelling NATM tunnels



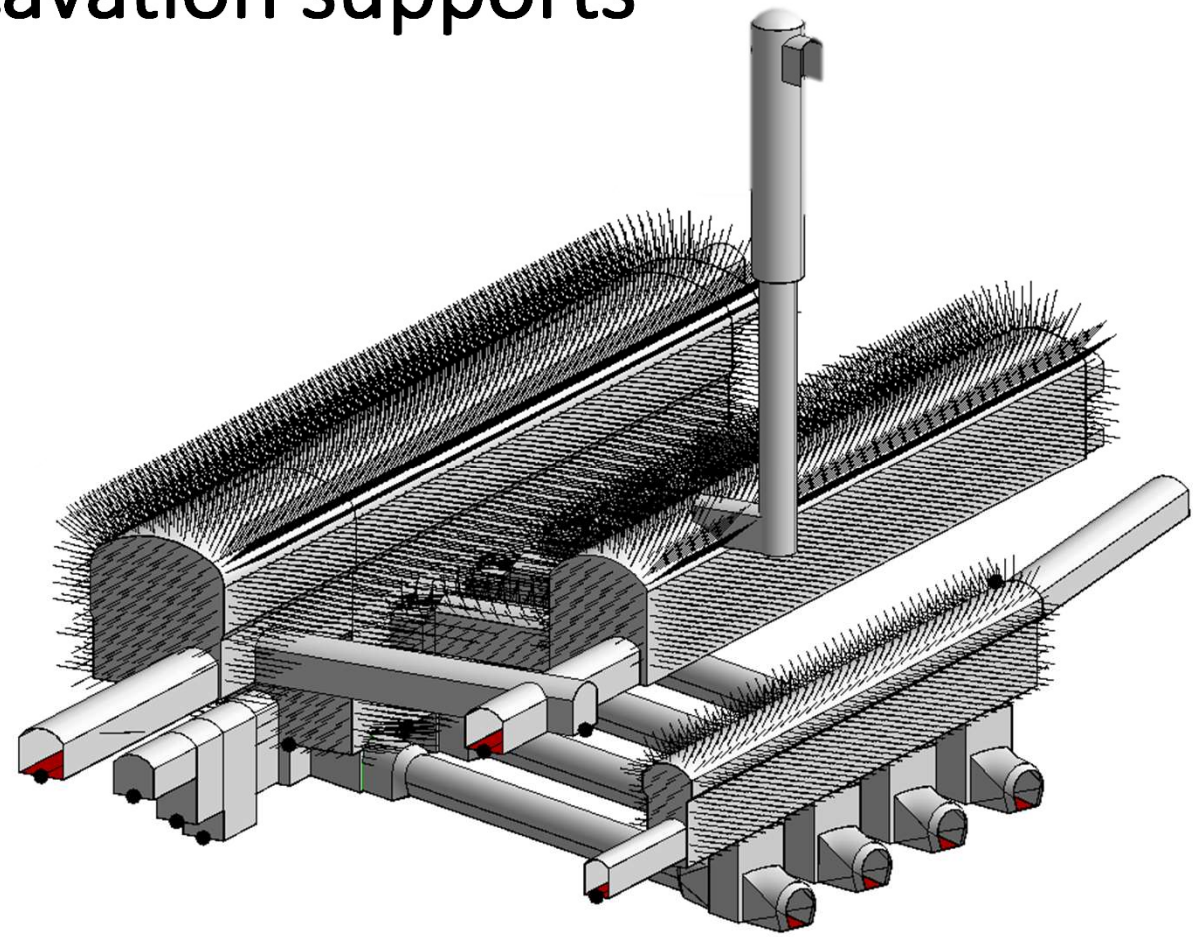
INFORMATION



Dynamo

Modelling of excavation supports

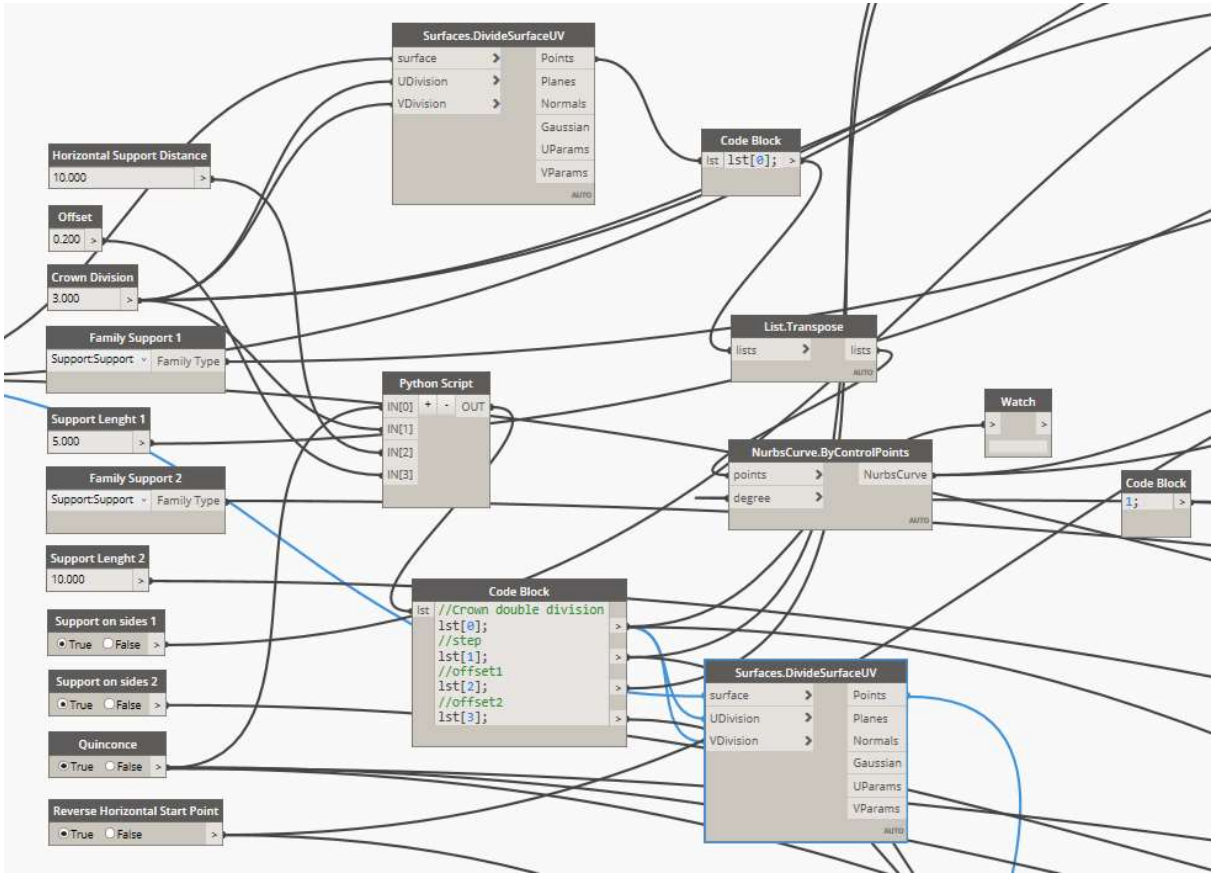
- Dynamo has been used also for modelling of supports
- Clicking the surface, defining input data, supports were modelled automatically



Dynamo

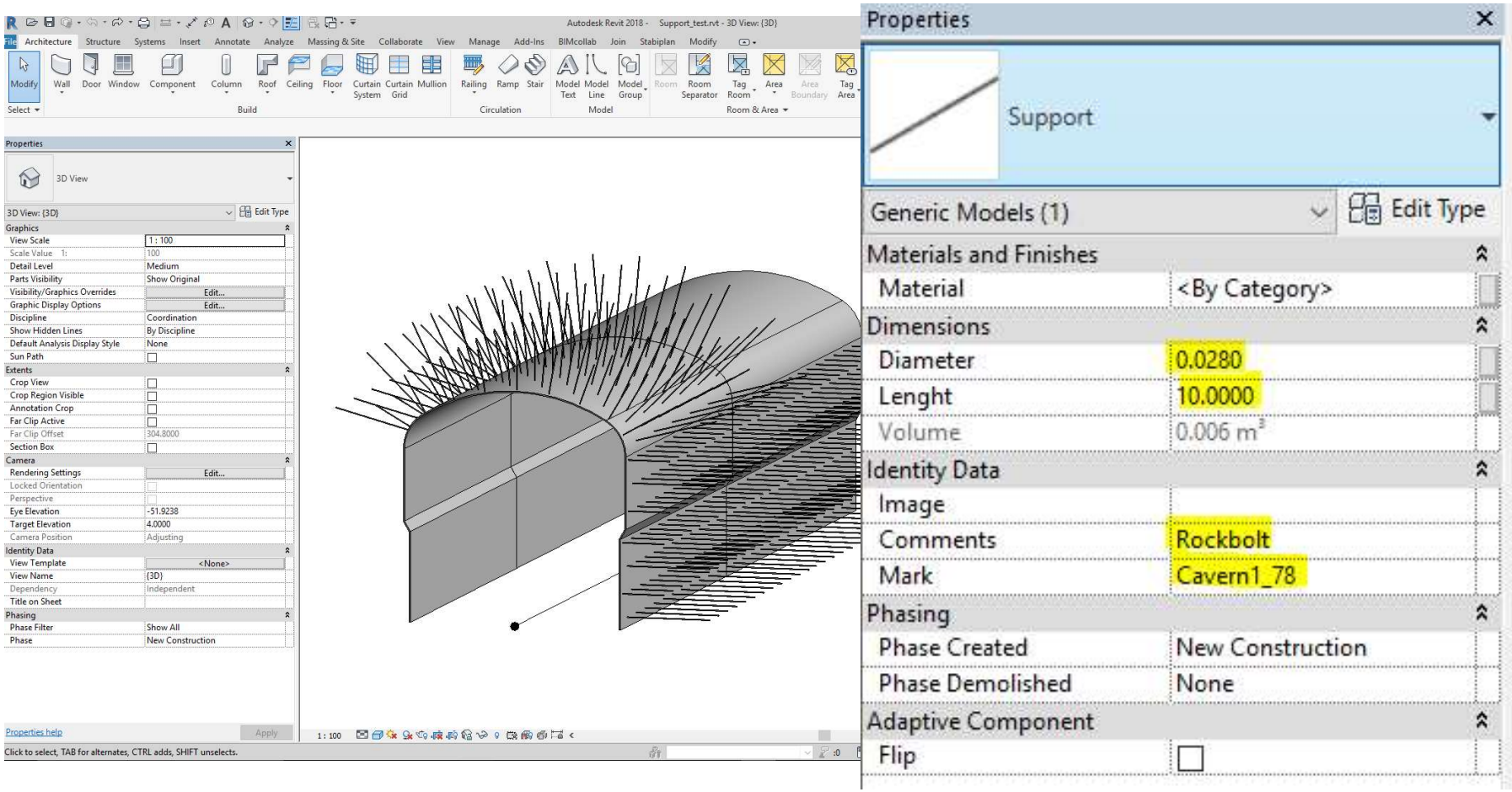
Modelling of excavation supports

- The code allows to control:
- Initial offset of the starting point;
- X support distance
- Y support distance
- Support length
- Support radius
- Support material and tipology
- Set the type of support disposition (quinconce or normal)



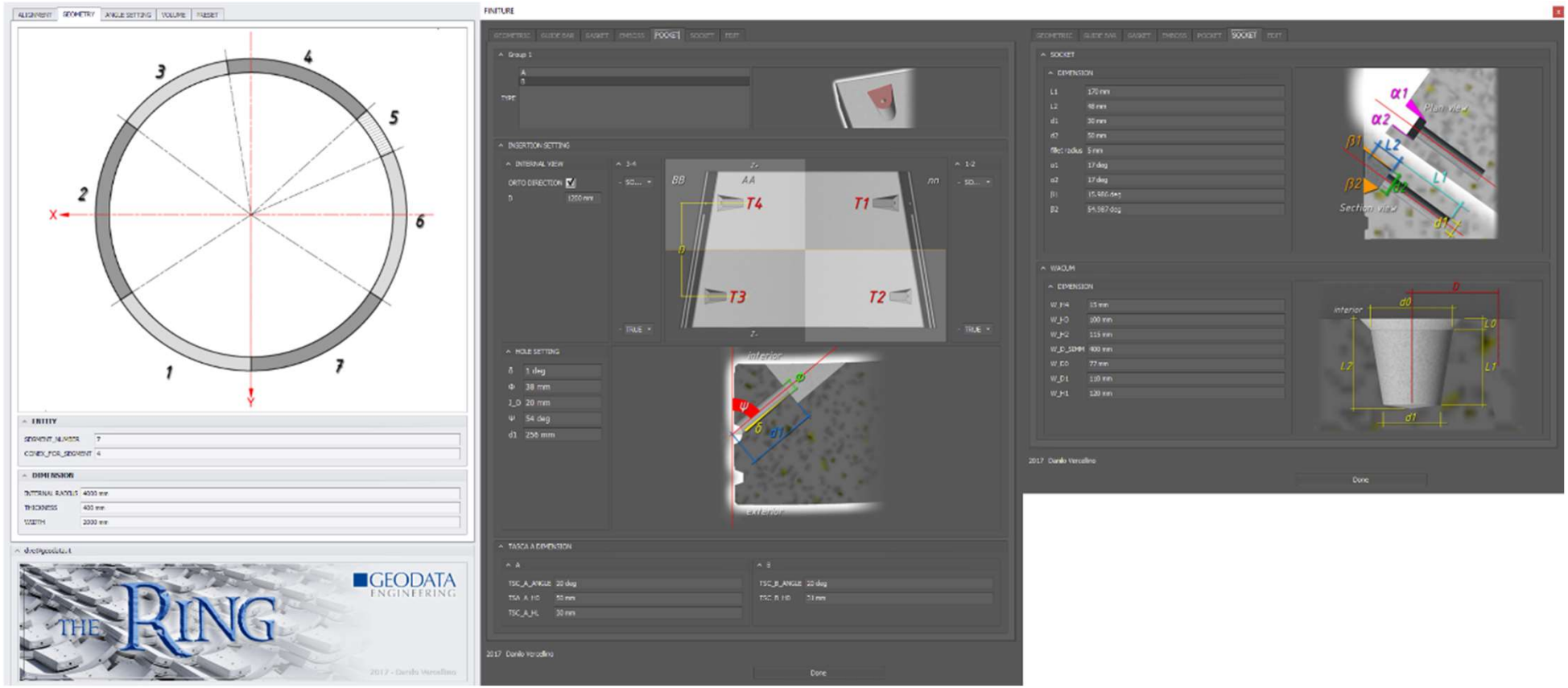
Dynamo

Modelling of excavation supports



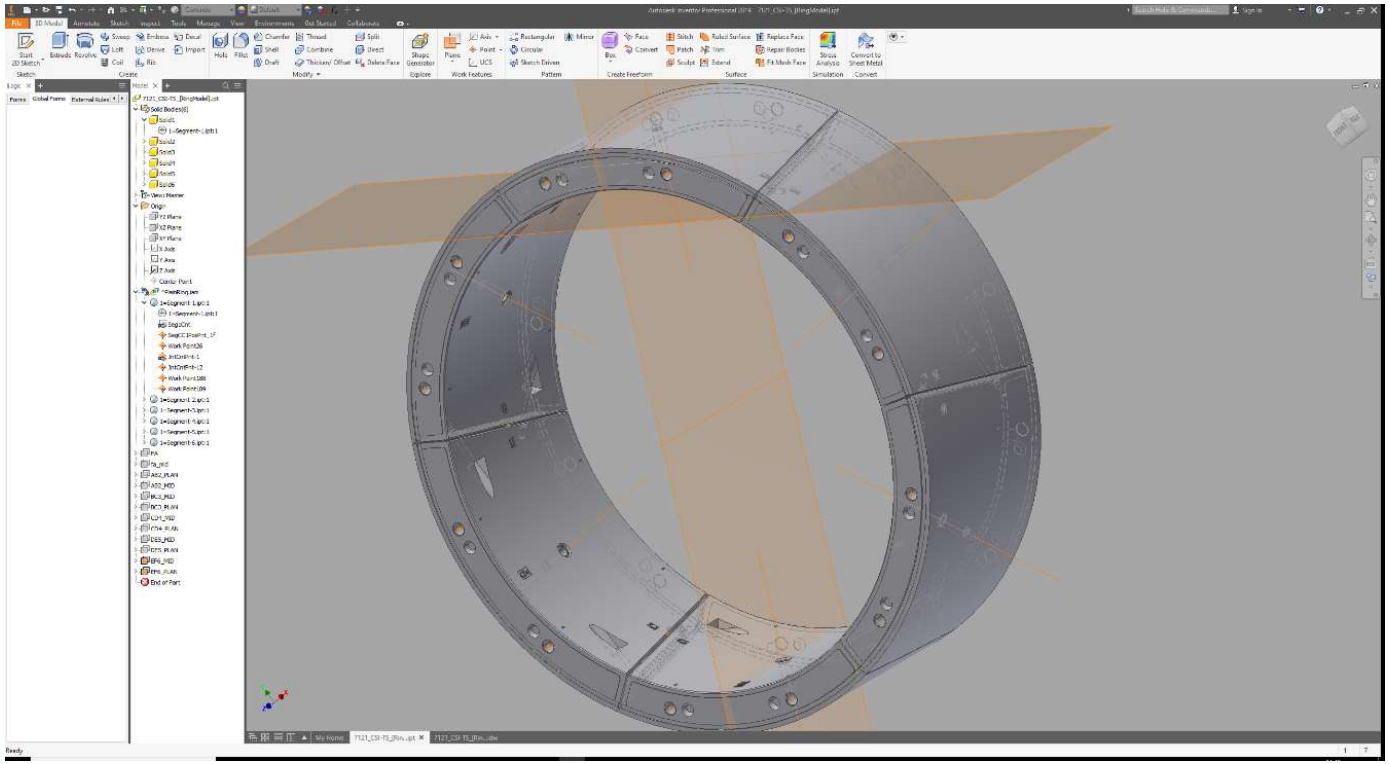
AUTODESK® INVENTOR®

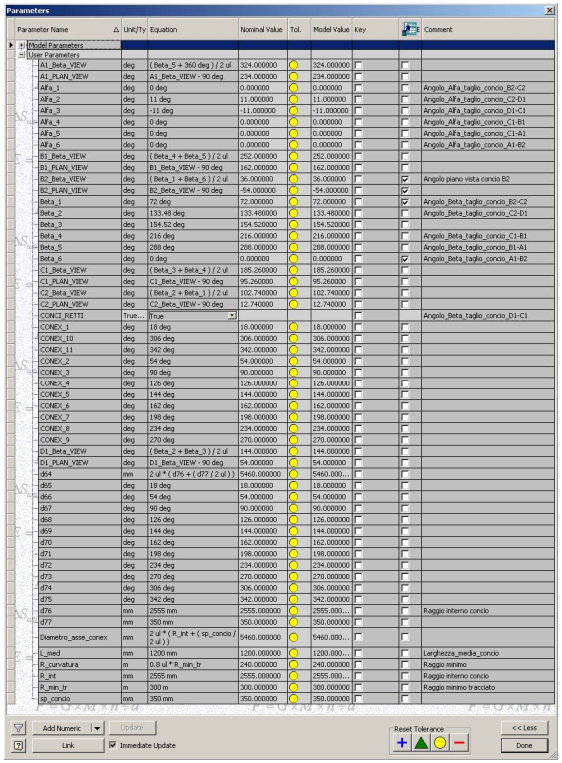
Design TBM segments



AUTODESK®
INVENTOR®

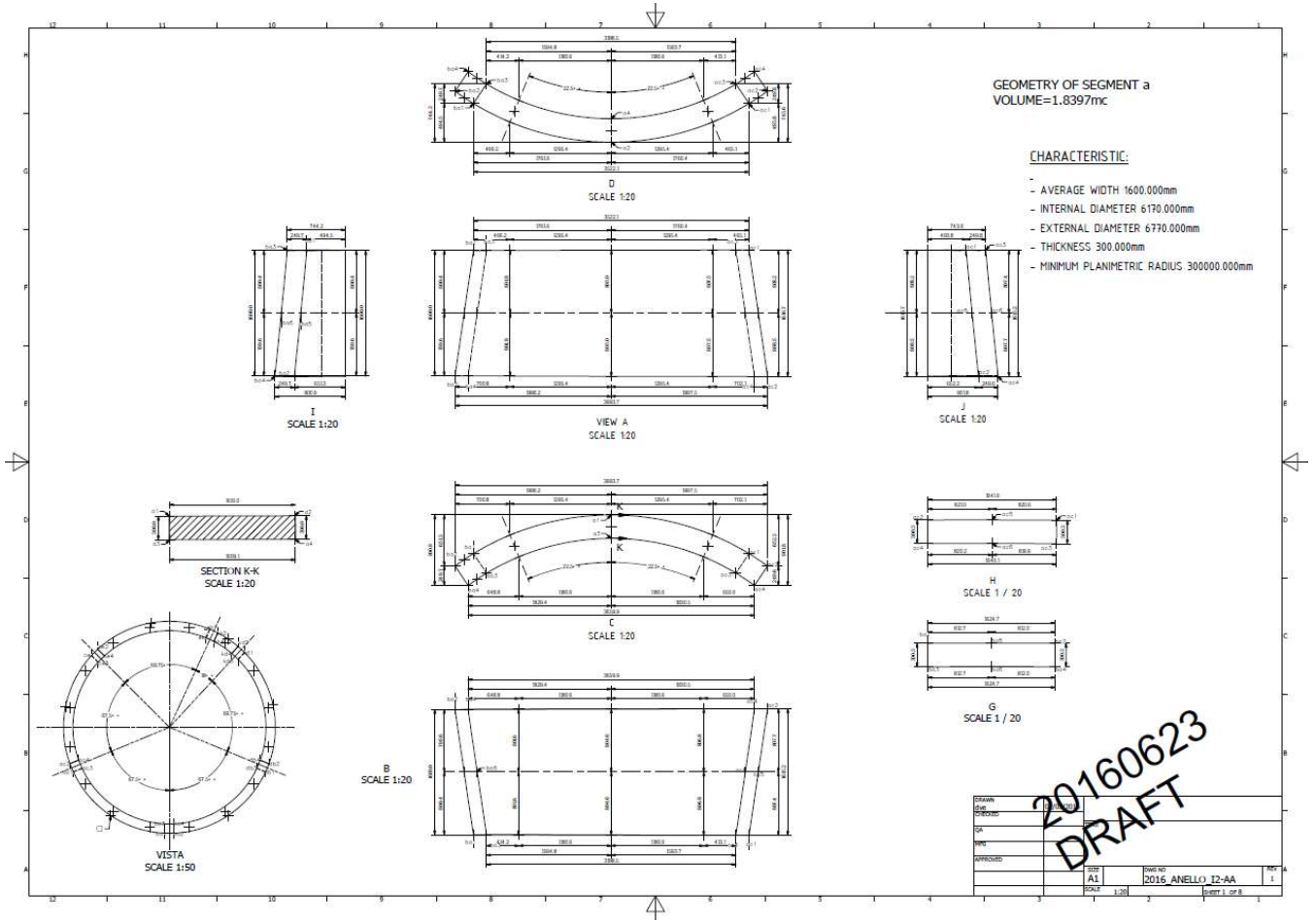
Design TBM segments



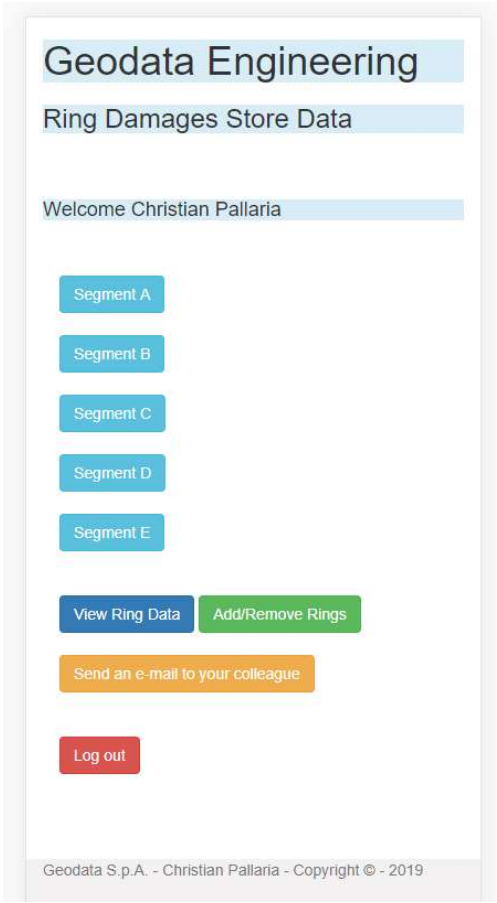


AUTODESK® INVENTOR®

Design TBM segments



WebApp for TBM Survey

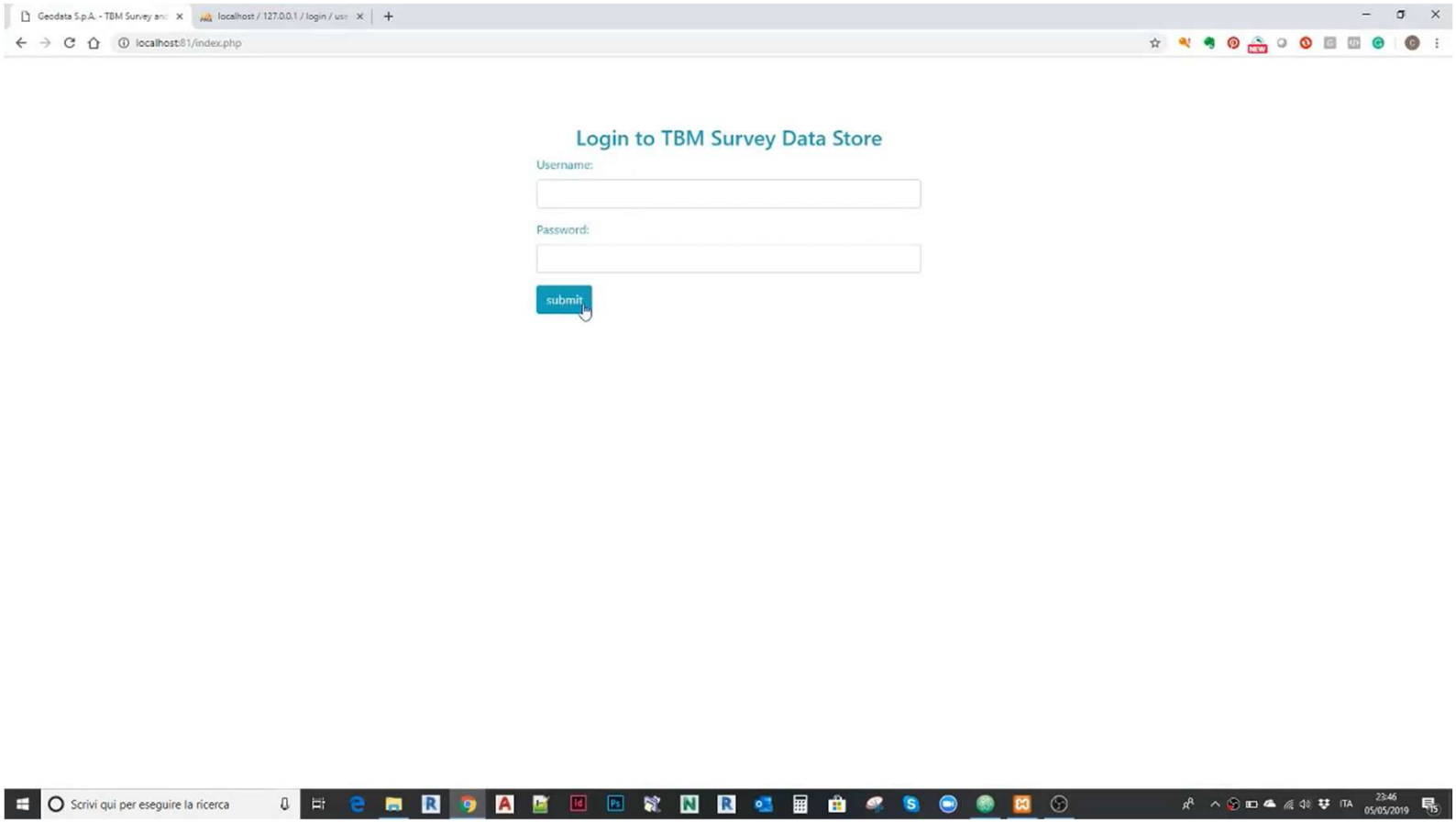


A Web App able to store data about segment damages during excavation, setting the data, time and name of the inspector.

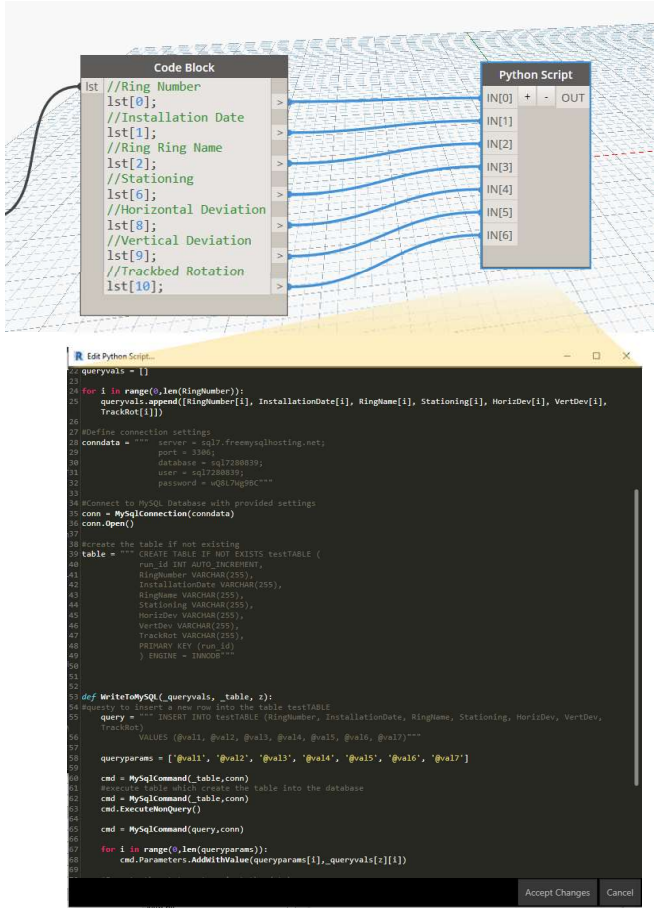
Ring VMT data

Ring Number	Ring Position	Stationing	Installation Date	X	Y	Z	Horizontal Deviation	Vertical Deviation
1	U13	27941,38	23.05.2018 18:27:10	400217,058	4568159,562	51,136	14	-43
2	U08	27939,88	24.05.2018 07:00:38	400218,015	4568158,407	51,147	61	-32
3	U13	27938,37	24.05.2018 15:09:40	400219,004	4568157,270	51,144	71	-35
4	U15	27936,87	24.05.2018 22:14:33	400220,011	4568156,157	51,185	53	6
5	U10	27935,37	26.05.2018 15:53:50	400221,019	4568155,044	51,181	34	2
6	U05	27933,87	26.05.2018 23:44:07	400222,031	4568153,936	51,197	8	18
7	U07	27932,37	27.05.2018 06:28:25	400223,026	4568152,809	51,206	8	27
8	U12	27930,87	28.05.2018 16:17:58	400224,026	4568151,695	51,200	-4	21
9	U04	27929,37	29.05.2018 03:52:33	400225,026	4568150,579	51,204	-15	25
10	U09	27927,87	29.05.2018 11:37:20	400226,022	4568149,456	51,188	-19	9
11	U01	27926,37	29.05.2018 18:07:55	400227,012	4568148,326	51,178	-13	-1
12	U15	27924,88	30.05.2018 00:29:36	400227,996	4568147,209	51,185	-12	6
13	U07	27923,37	30.05.2018 13:47:31	400228,990	4568146,068	51,184	-1	5
14	U15	27921,88	30.05.2018 23:01:06	400229,973	4568144,950	51,195	1	16
15	U07	27920,38	31.05.2018 03:48:31	400230,975	4568143,840	51,193	-16	14
16	U02	27918,88	31.05.2018 10:41:31	400231,977	4568142,714	51,194	-22	15
17	U07	27917,36	31.05.2018 16:49:18	400232,969	4568141,563	51,195	-4	15
18	U12	27915,85	31.05.2018 22:45:46	400233,967	4568140,438	51,186	-7	7
19	U14	27914,35	01.06.2018 02:14:21	400234,960	4568139,308	51,181	-4	2
20	U16	27912,85	01.06.2018 05:59:05	400235,966	4568138,199	51,165	-24	-14
21	U05	27911,36	01.06.2018 10:19:10	400236,961	4568137,095	51,186	-40	7
22	U07	27909,85	01.06.2018 14:18:47	400237,954	4568135,952	51,184	-27	4

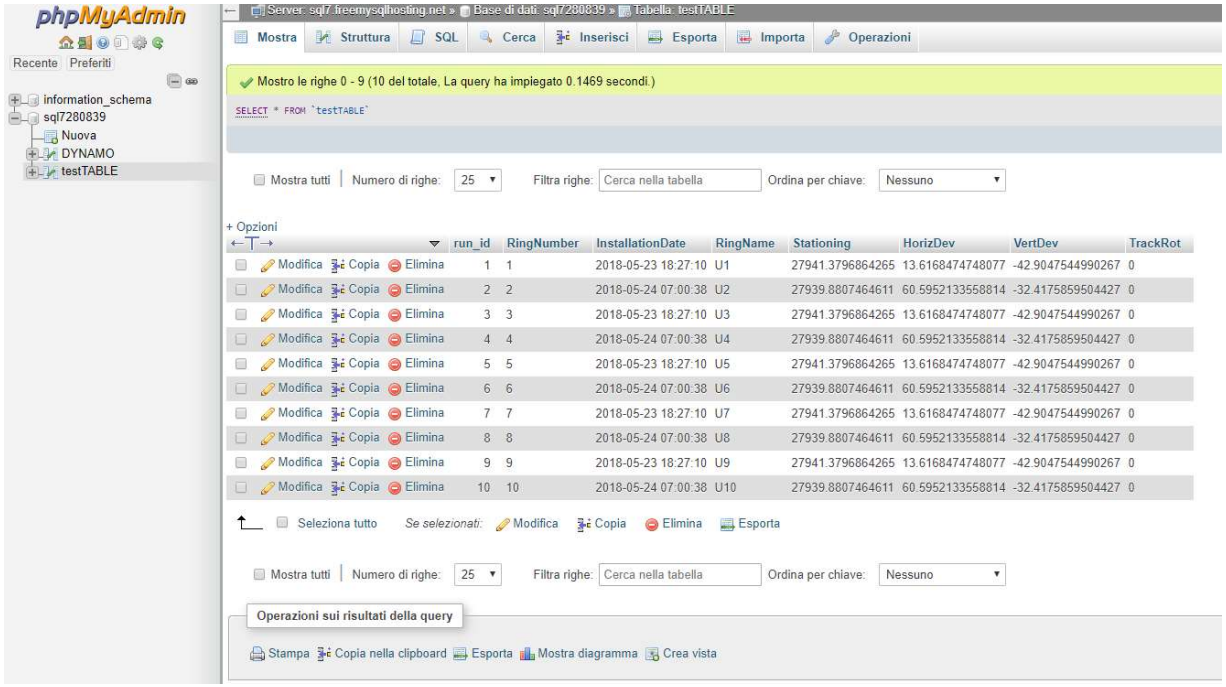
WebApp for TBM Survey



Connecting to MySQL DB



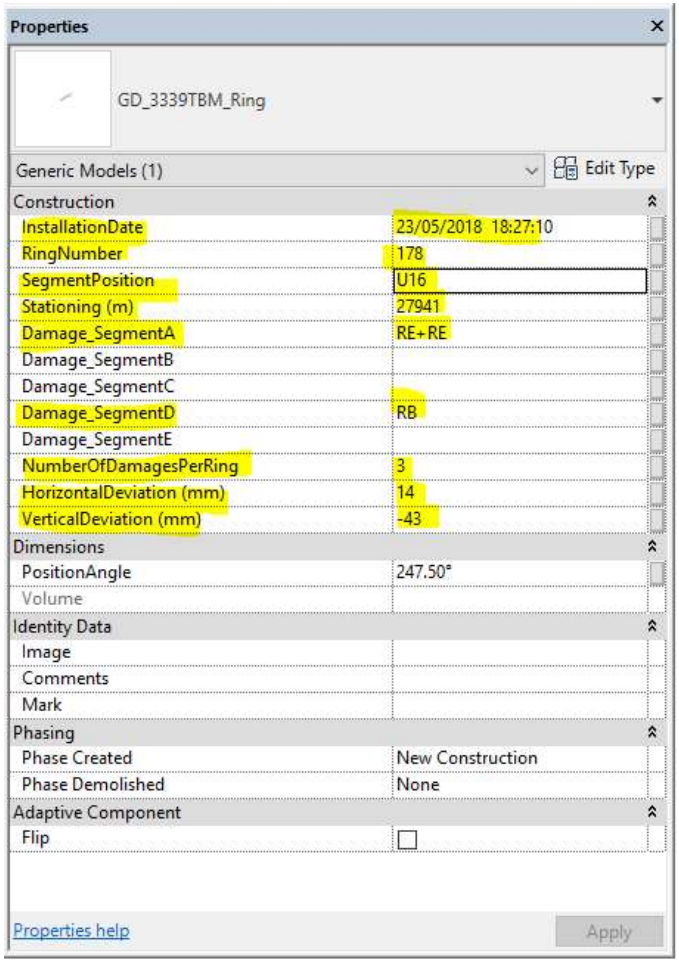
While the inspector is storing data, a Dynamo code can connect the model to a MySQL database and read that data, updating the model automatically

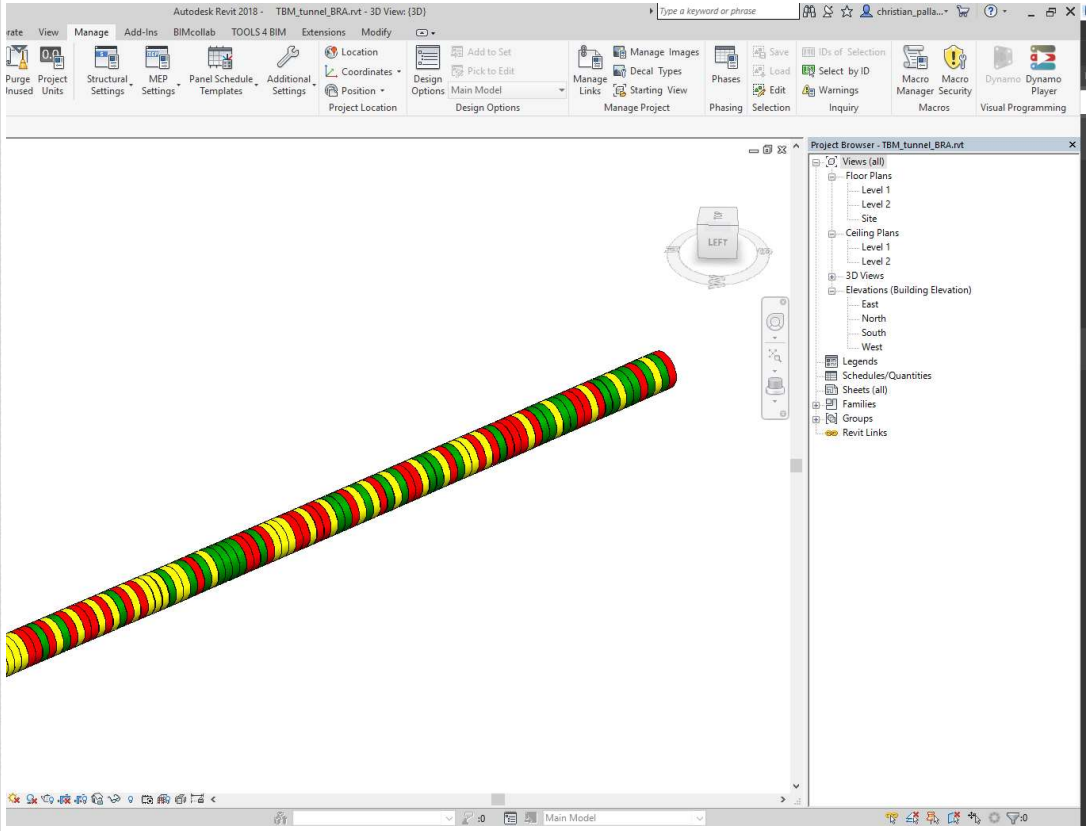


TBM Survey workflow

Dynamo

python™ MySQL





Try the WebApp

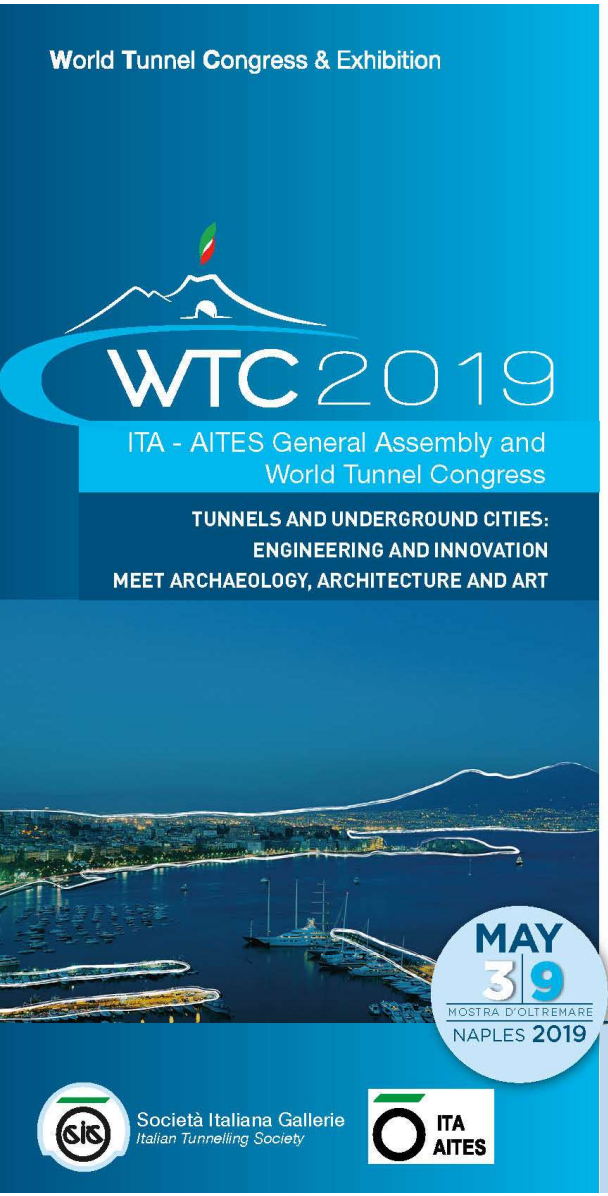
Scan the code

or go to

www.wtc2019.altervista.org

User: wtc2019

Password: wtc2019



Thank you!

Christian Pallaria

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