GEOTECHNICAL SENSOR MONITORING TOWARDS DIGITAL TWIN APPLICATION

TYRÉNS

ISSMGE TC 222

Webinar 13 November 2025

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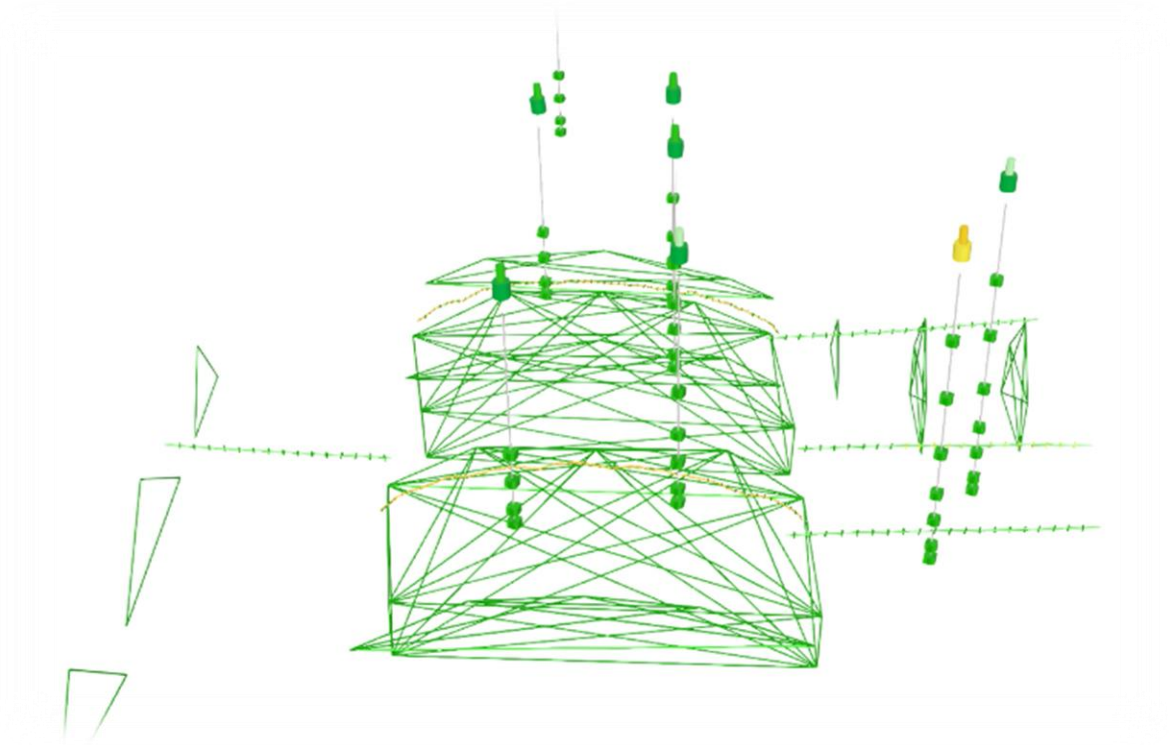
Tyréns Sweden AB



OUTLINE

- The drivers
- GeoBIM data management
- A few examples
- Sensor monitoring
- Do we have a digital twin?
- Future work

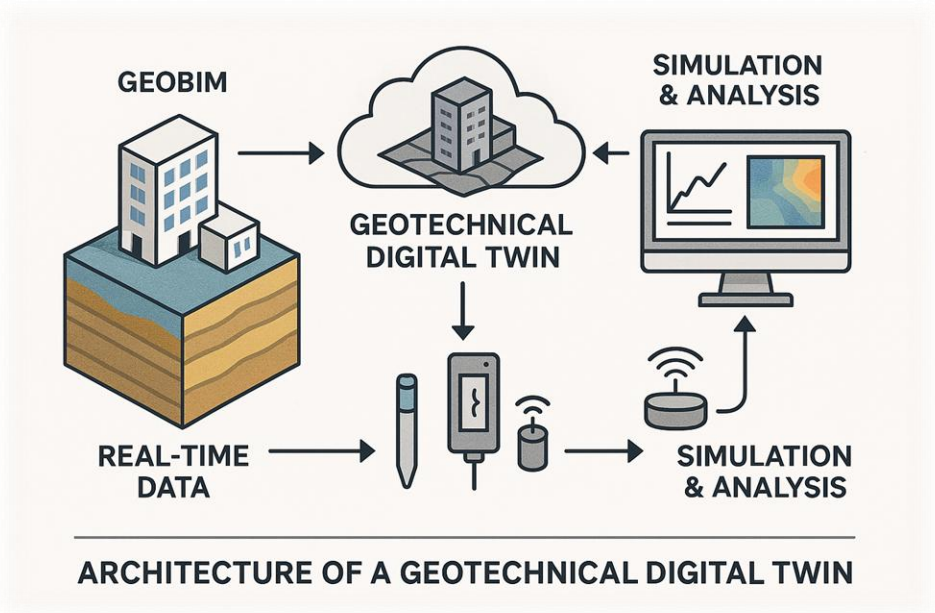


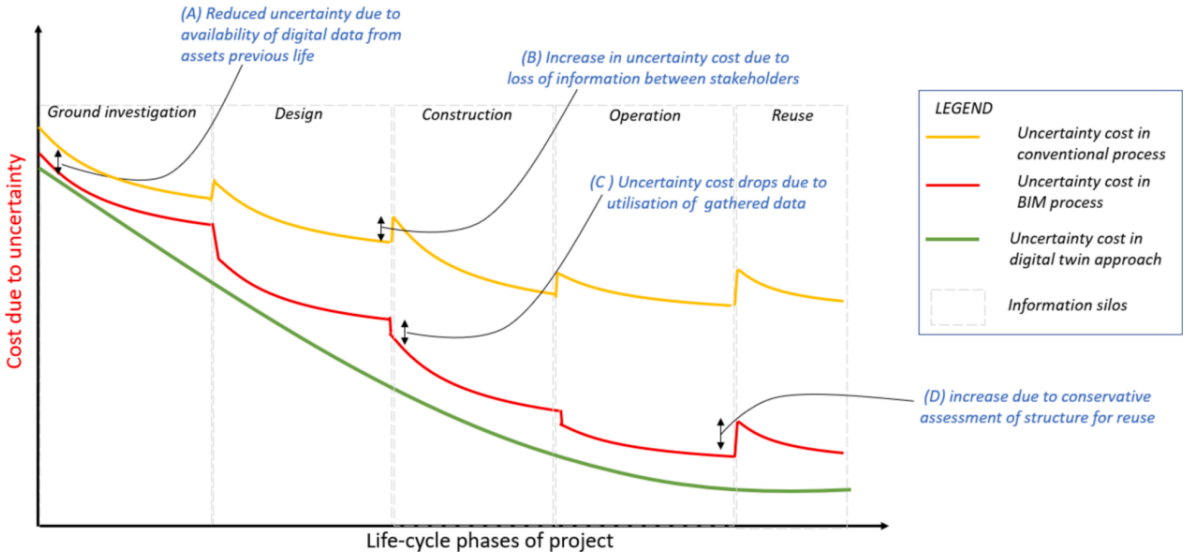
Figure by Copilot

TYRÉNS SWEDEN

- 2 000 employees
- 140 geotechnicians
- Subsurafce disciplines – 350 employees
  - Geotechnics
  - Environment
  - Rock engineering
  - Groundwater
- Exploring **digitizing towards geotechnical digital twin applications**

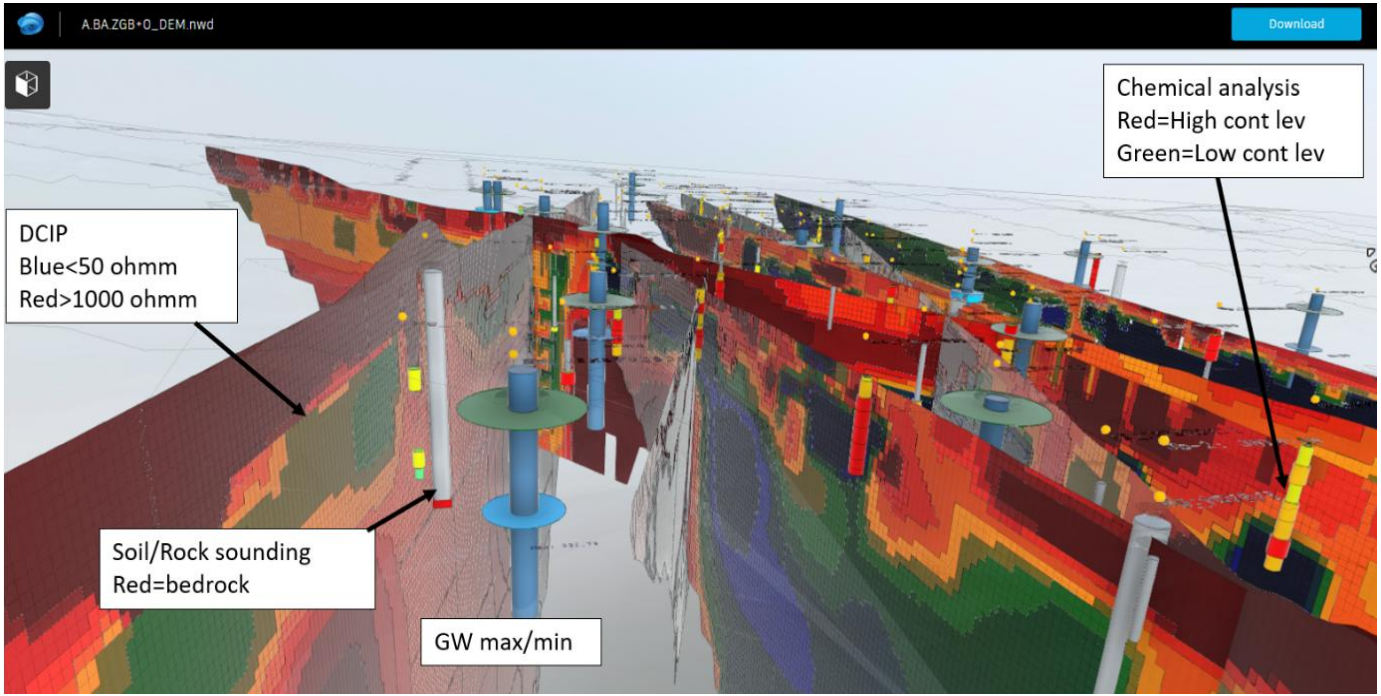
WHY GEOTECHNICAL DIGITAL TWIN?

Geotechnics is very much about uncertainties



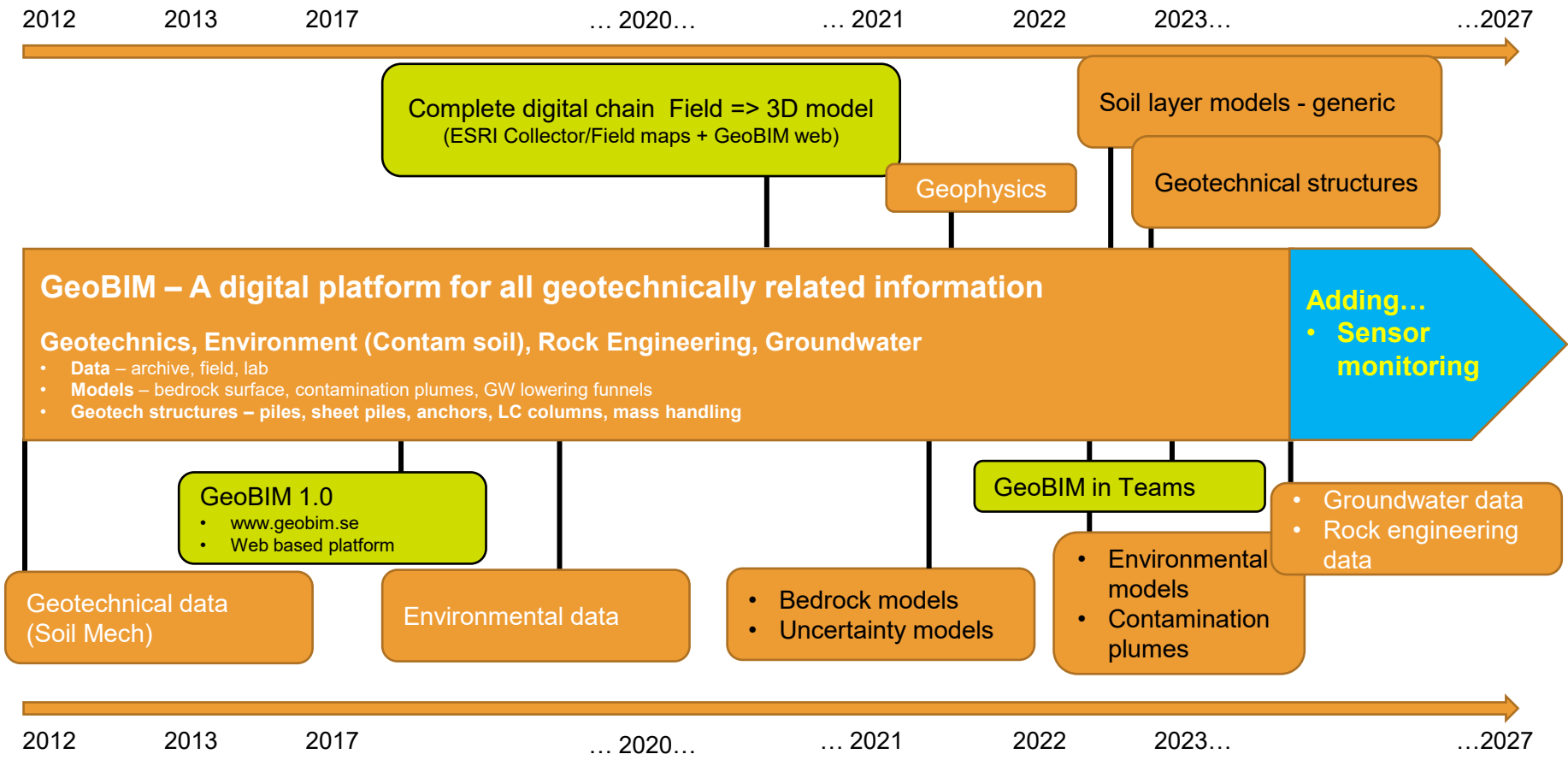
Babanagar N., et al, 2025, Tunnelling and Underground Space Technology 155

THE DRIVER

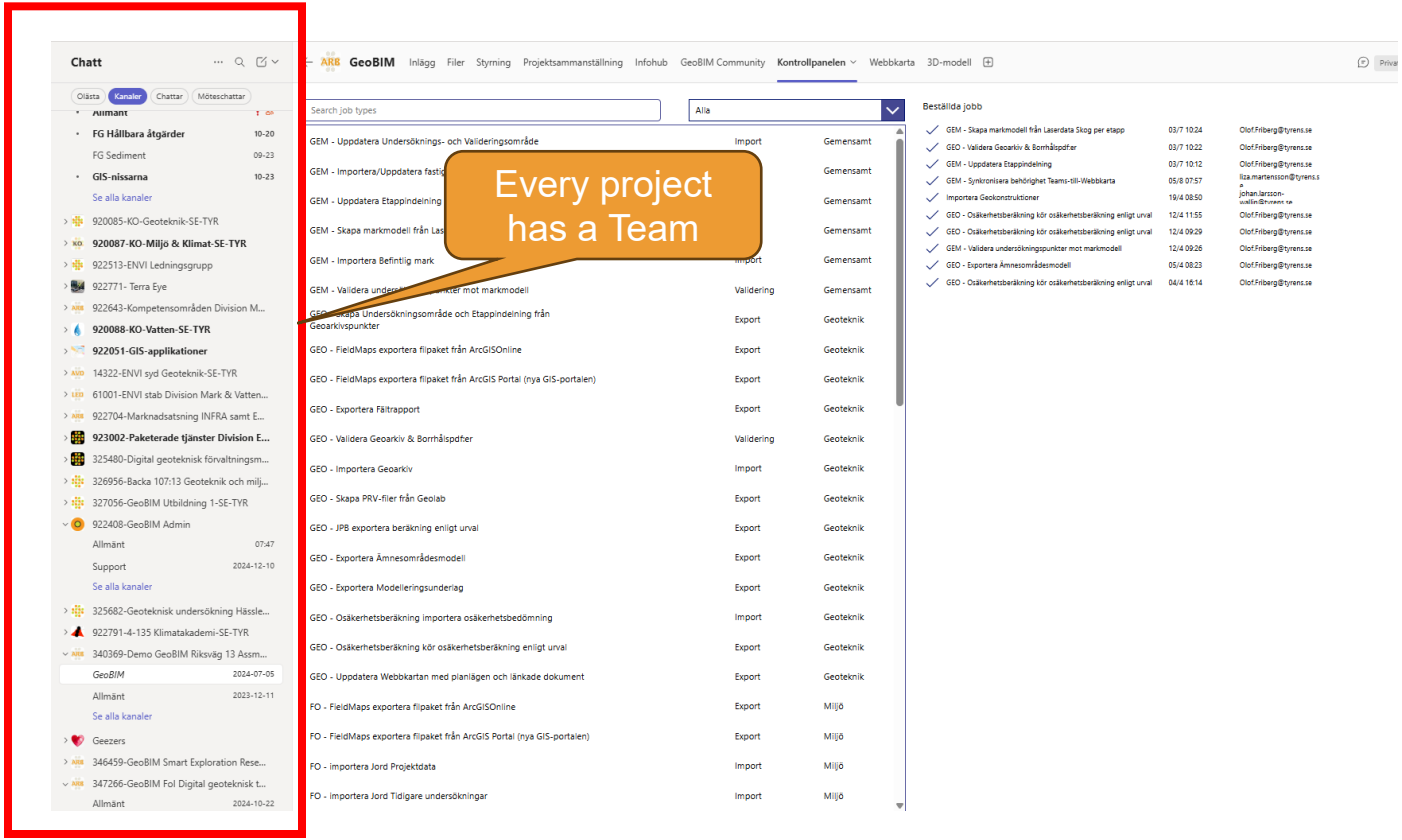


Project Bräcke railway yard, Sweden, 2019.

GEOBIM DATA MANAGEMENT



WHY MICROSOFT TEAMS?!



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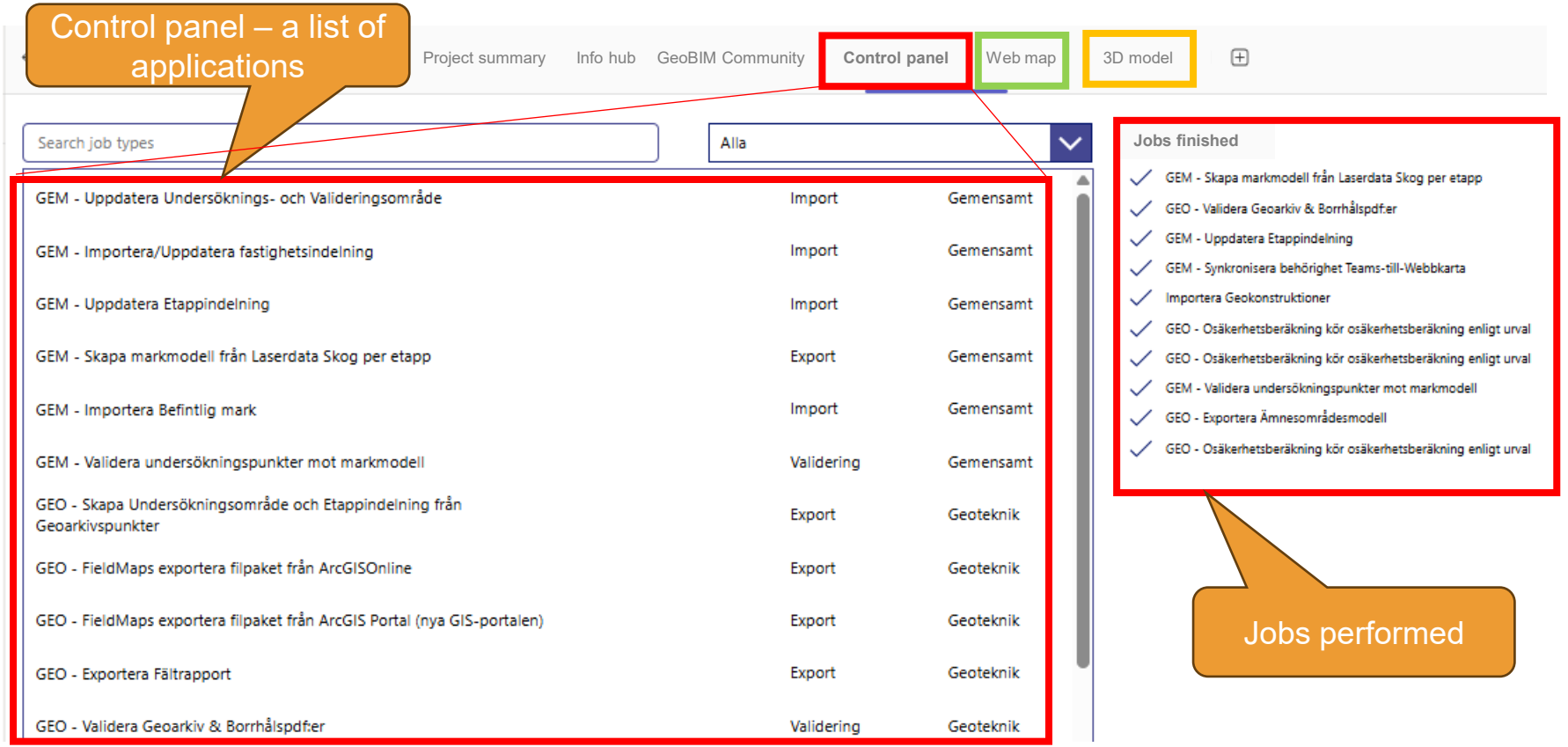
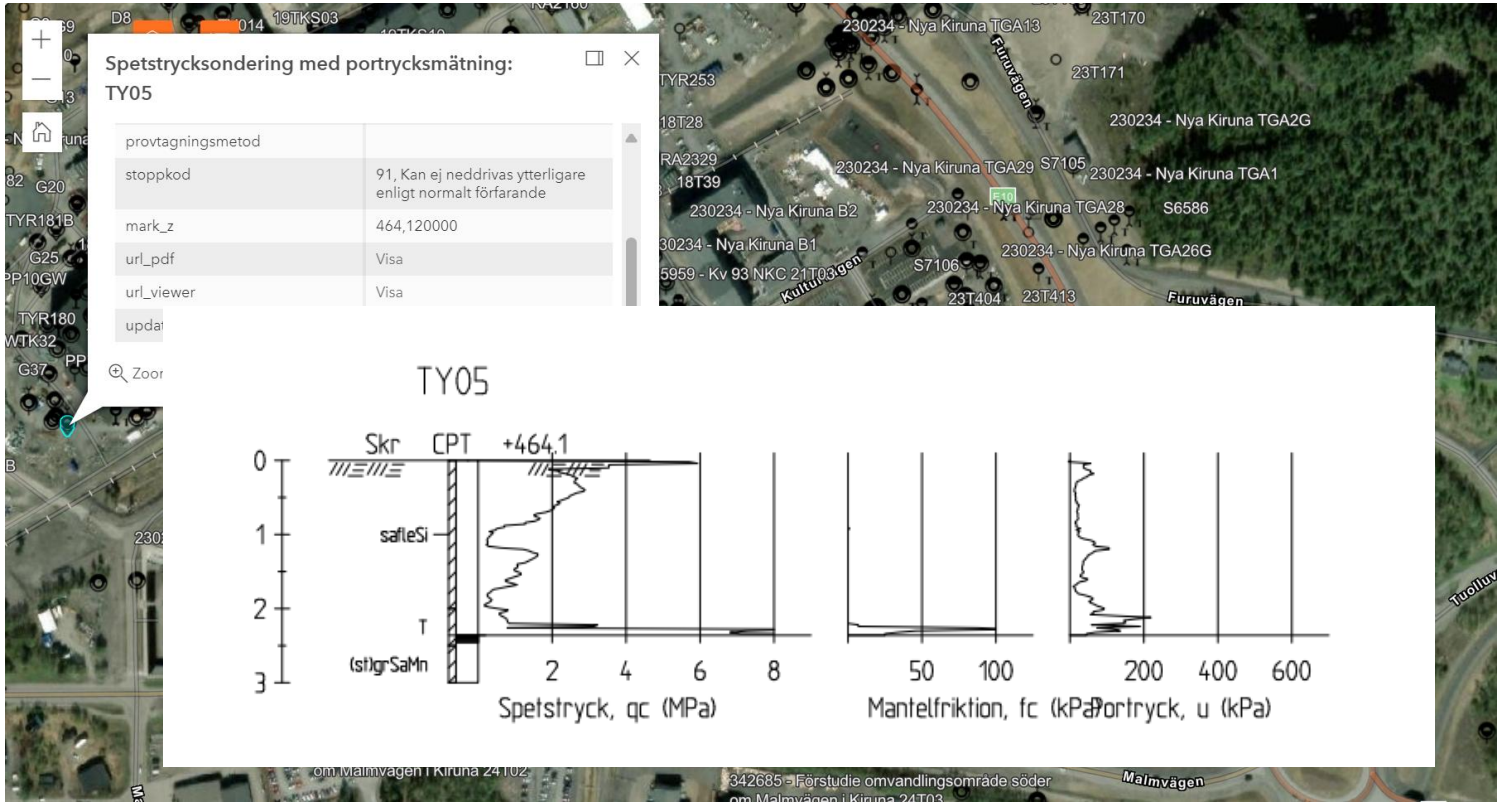


Control panel | Web map | 3D model

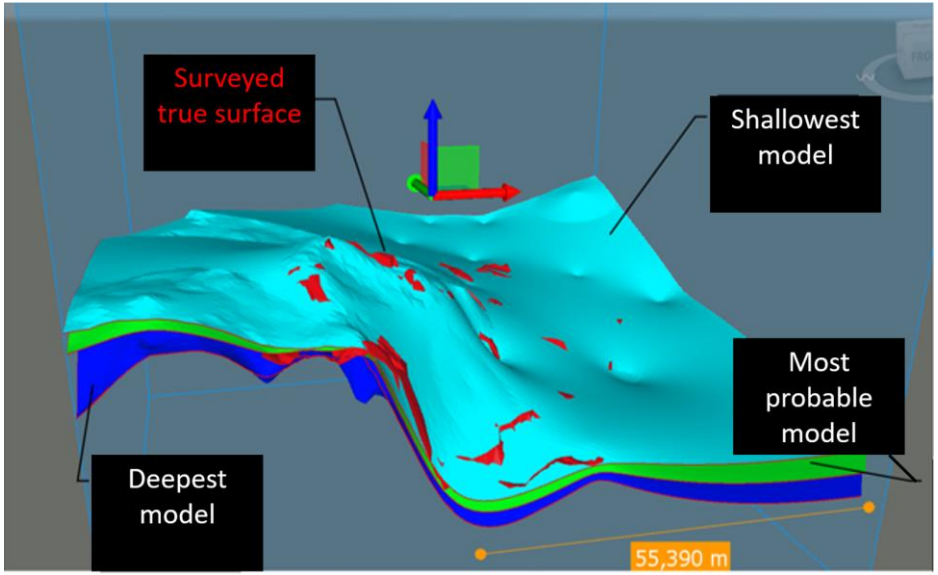
GeoBIM – THE DIGITAL ARCHIVE

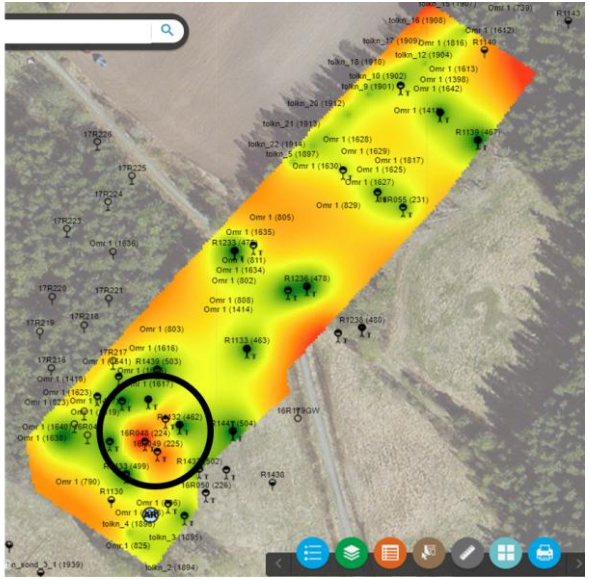


Control panel | Web map | 3D model

ADVANCED ANALYSIS TOOL

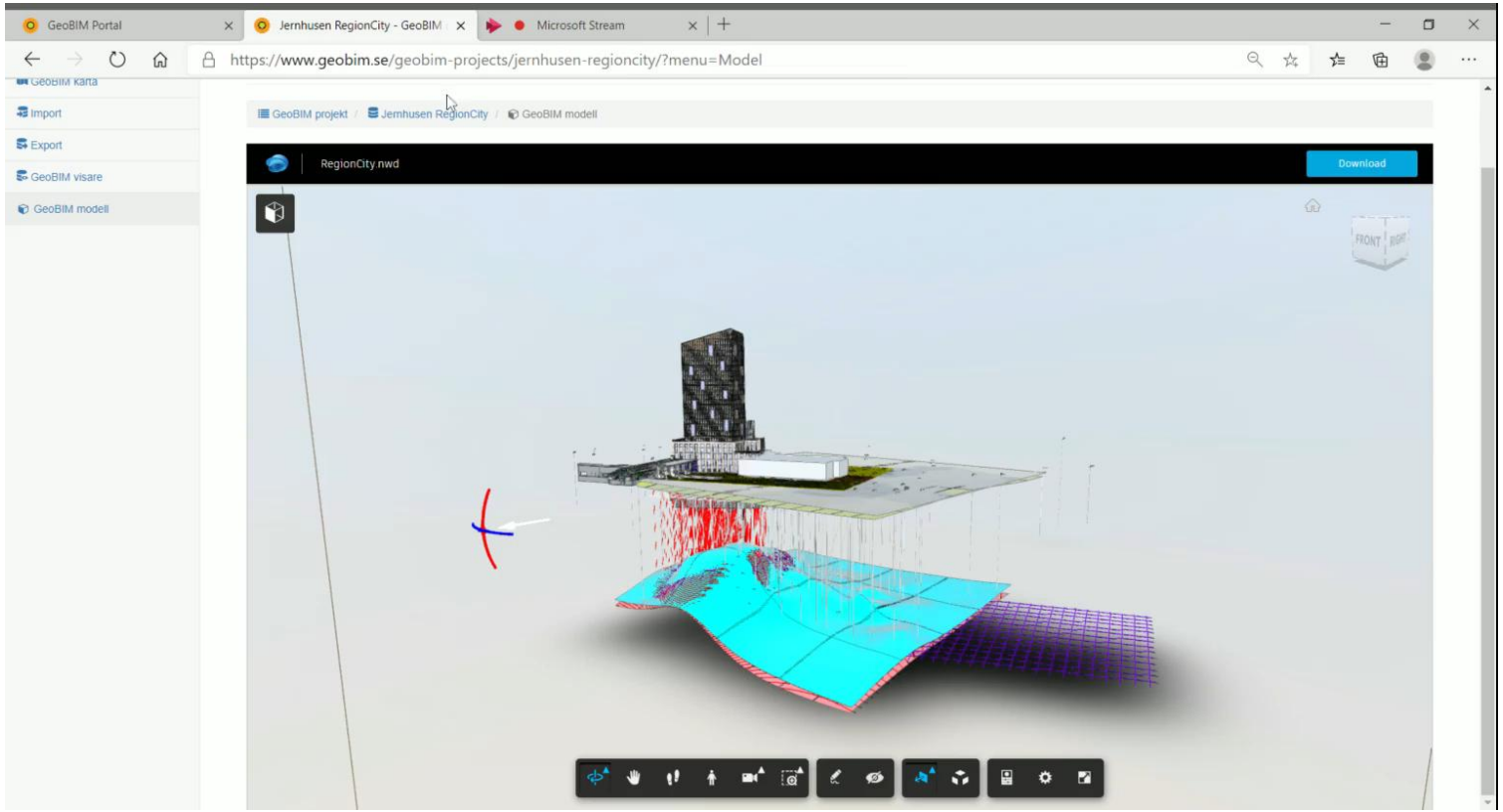
BEDROCK SURFACE INCL UNCERTAINTY MAP





Control panel | Web map | 3D model

VISUALIZATION



Permit by Jernhusen

CUSTOMER APPLICATION

SKANSKA – HIGH SPEED TRAIN FOUNDATION

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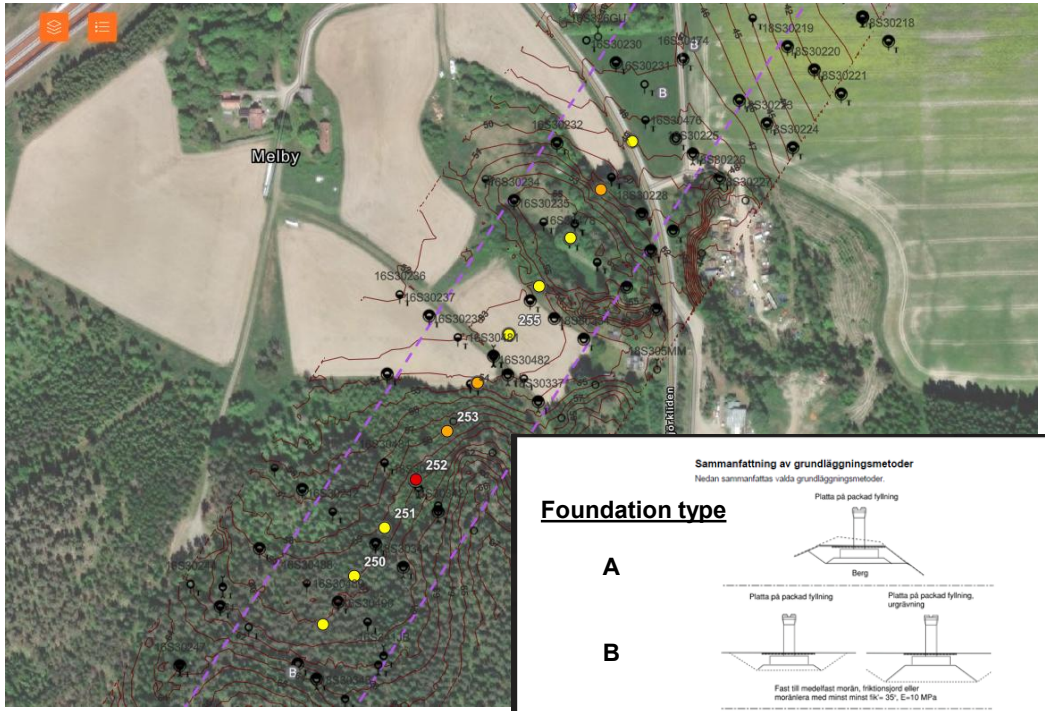
SKANSKA

Control panel | Web map | 3D model

ANALYSIS FOUNDATION TYPE

TYRÉNS SMART BUILT ENVIRONMENT SKANSKA



General

Sammanfattning av grundläggningsmetoder

Nedan sammanfattas valda grundläggningsmetoder.

Foundation type

A

B

C

Jordprofil 1
Urvalskriterium i GeoBIM-databasen:
Berg inom z<1.0 m umv

Jordprofil 5-6
SAMLAT urvalskriterium i GeoBIM-databasen:
ϕ > 35 gr inom z<20 m umv **ELLER** c_u = 50-100 kPa inom z<50 m umv

Jordprofil 2- 4, 7 (MS)
SAMLAT urvalskriterium i GeoBIM-databasen:
ϕ = 27-35 gr inom z<50 m umv **ELLER** c_u < 50 kPa inom z<50 m umv **ELLER** Organisk jord inom z<8 m umv

OVERCOMING HINDERS

HINDERS

- Lack of **data formats**
- Lack of **transfer formats**

SOLUTION

- Best practise
  - Experts agreement
- Delivery specifications
  - Project
  - Company
  - Nation
  - …

DELIVERY SPECIFICATION

IMPORT OF GEOTECHNICAL STRUCTURE DATA

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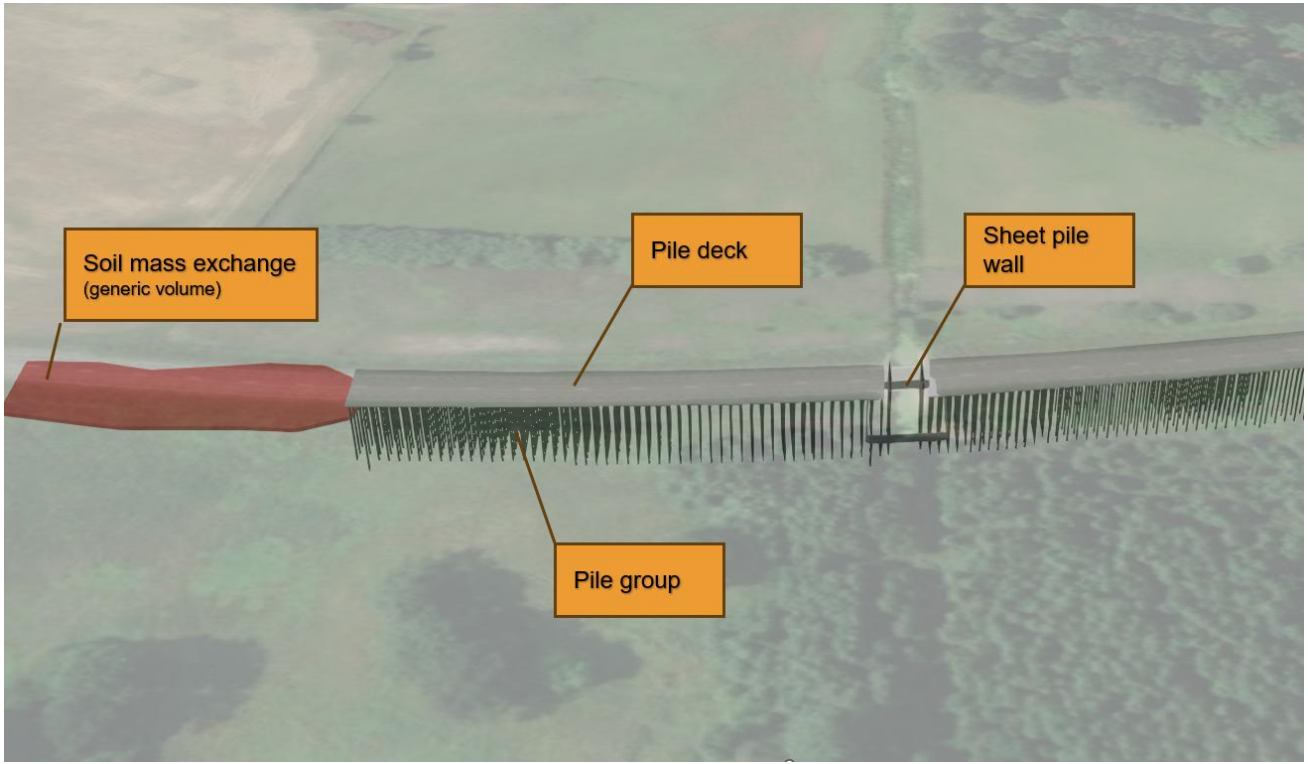
	Piles									
	Position					Pile type				
Coordinate system	Elevation system	Northing (X)	Easting (Y)	Inclination (to ground surface), n:1	Pile head elevation + xx.xx	Material	Installation method	Type	Function	Thickness (Steel piles)
SWEREF 99 13 30	RH2000	6159514,71	165612,3		36,48	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159514,77	165614,6		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159514,62	165616,8		36,48	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159514,57	165619,1		36,46	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159514,51	165621,4		36,48	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159514,43	165623,8		36,47	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159517,05	165612,4		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159516,94	165614,5		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159516,99	165616,7		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159516,77	165618,7		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159516,75	165621,6		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159516,67	165623,6		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159519,28	165612,3		36,5	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159519,24	165614,5		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159519,24	165616,9		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159519,07	165619,2		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159518,92	165621,5		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159519,1	165623,7		36,49	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,52	165612,4		36,51	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,36	165614,5		36,5	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,33	165616,7		36,5	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,34	165619,3		36,5	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,33	165621,6		36,5	Concrete	Hammer		Friction	
SWEREF 99 13 30	RH2000	6159521,27	165623,8		36,5	Concrete	Hammer		Friction	

TYRÉNS

ASSMÅSA, MALMÖ



Control panel | Web map | 3D model

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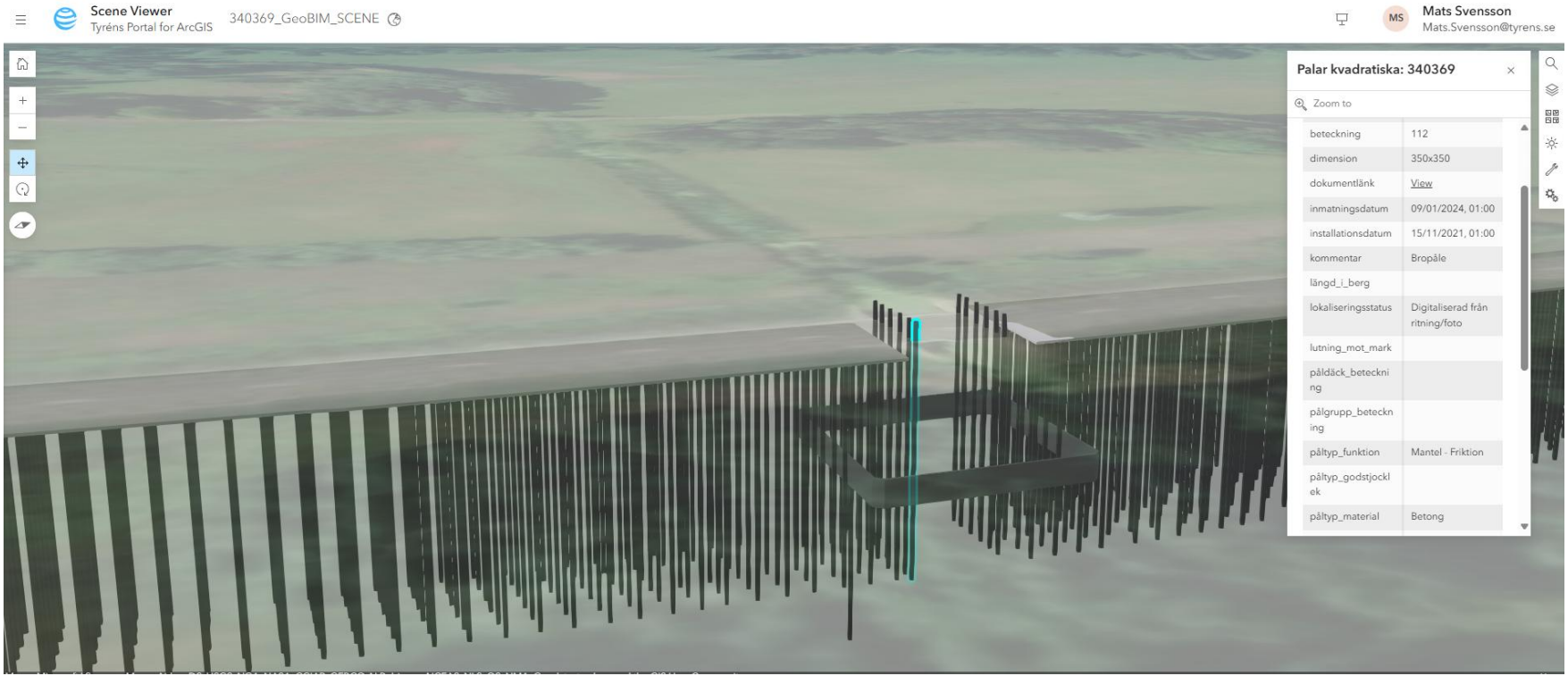


MISSING… ON THE ROAD TO A DIGITAL TWIN

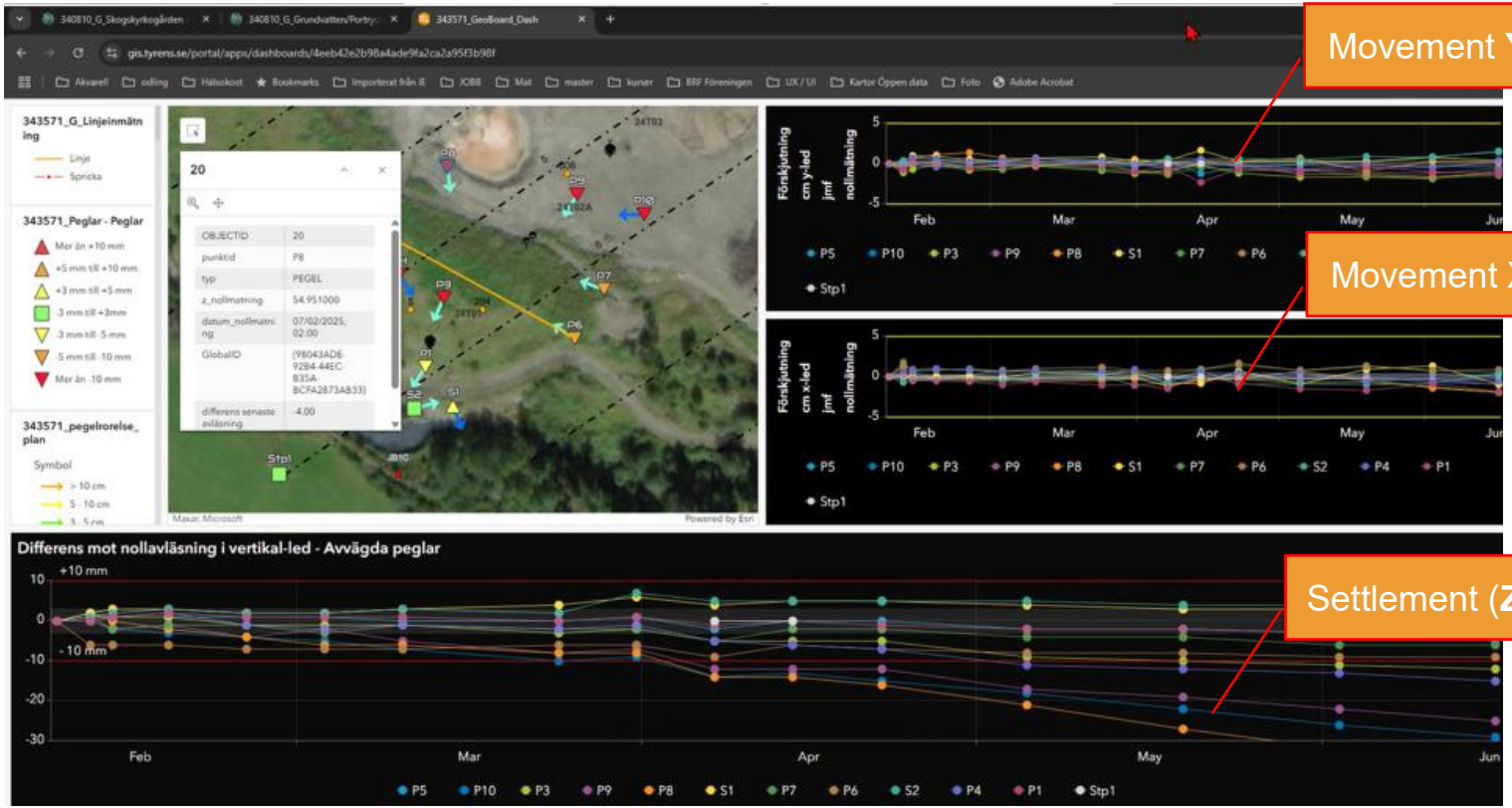
Sensor monitoring

SENSORS

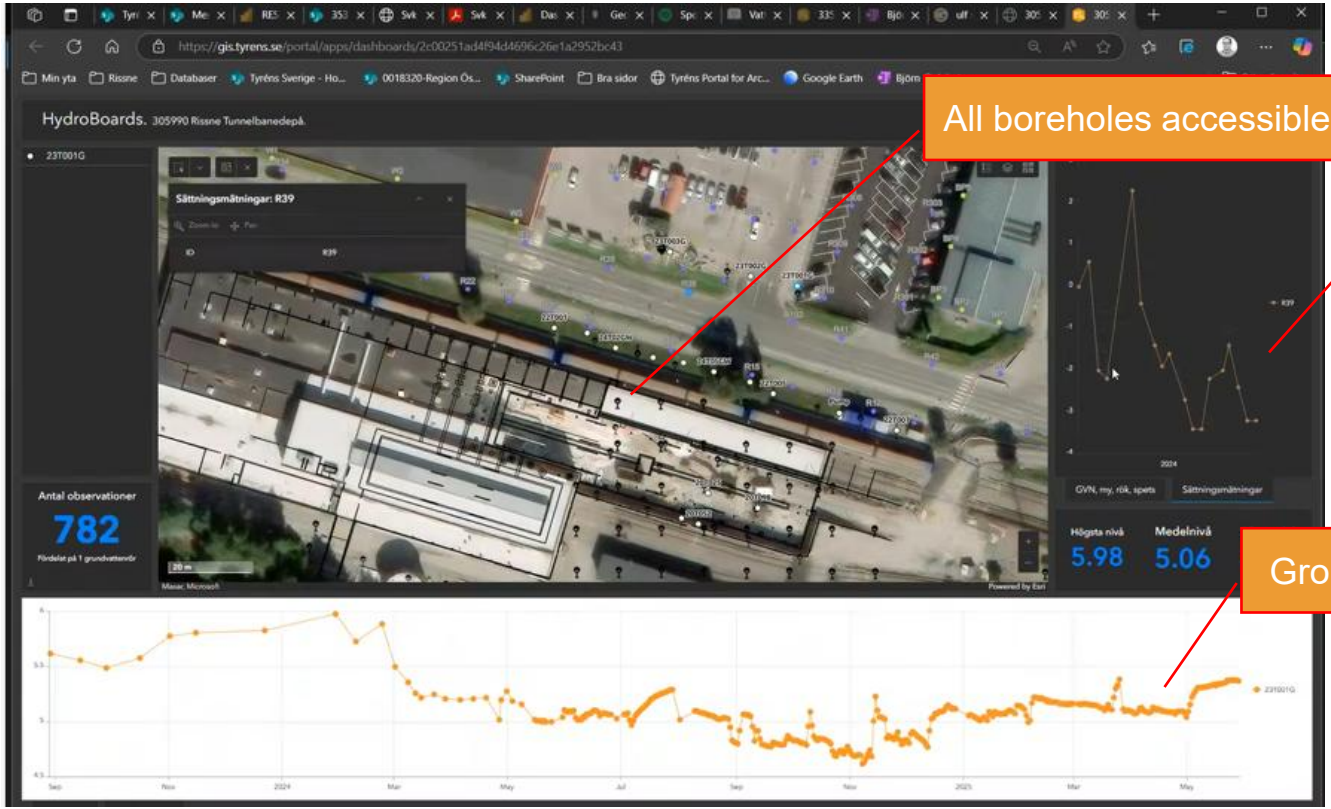
Delivery specifications for:

- Soil movement (surface) – X, Y, Z
- Inclinometers
- Groundwater – open pipes, piezometers
- Extensometers (tunnels)
- Fibre optics

LANDFILL, NORRKÖPING



RISSNE TRAIN DEPOT, STOCKHOLM



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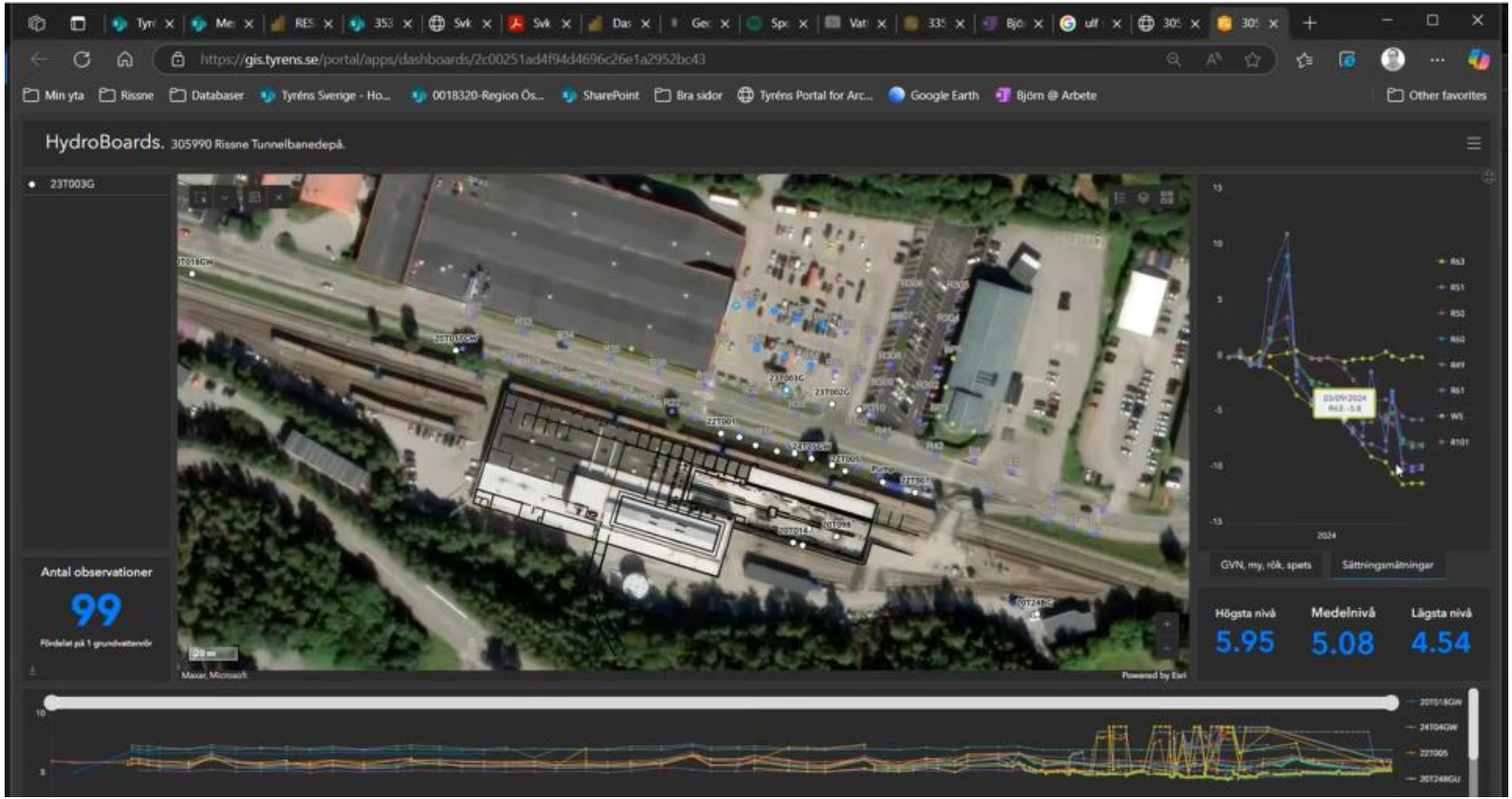
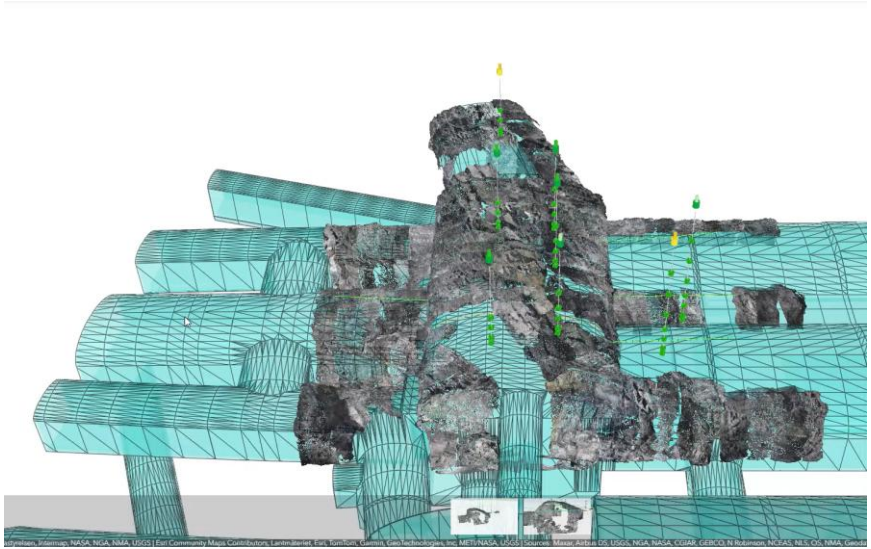
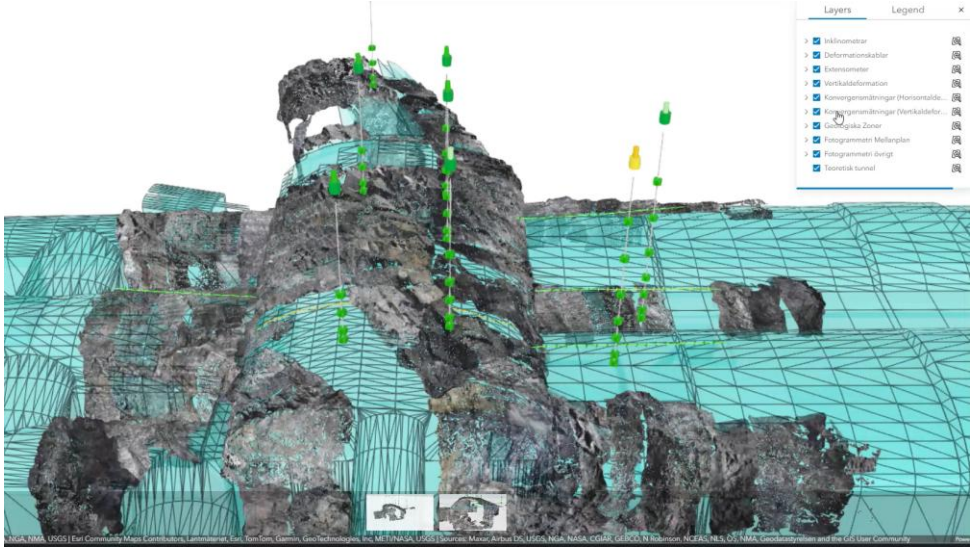


KORSVÄGEN, GOTHENBURG

RAILWAY TUNNEL STATION, WEST LINK PROJECT

TYRÉNS





KORSVÄGEN, GOTHENBURG

RAILWAY TUNNEL STATION, WEST LINK PROJECT

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Control Objects Basic data

Number	Type	Alarm.Nr	Tag
E4-9	D: Dub: z	EXTIV9	

Group	Category	Contractor	Status
EXT_W	E-IV		

Alt.Jämförelse	Xr-E-value	Yr-N-value	Zr value	Diff.
Med(7-14):2m			22.3550	-0.9mm

Zero measurement	X-E coordinate	Y-N coordinate	Measures 0	Diff. [mm]
2023-01-18			22.3660	-8.6mm

Latest registration	Measurement value
2025-07-03 11:30:(	**22.3541**

Day	Supplement[m]
0	0

Notes

250602/ONY: slutningsfel(0.37mm)
250528/PKH: slutningsfel(1.3mm)
240910/USV: replacement on 2024-08-28 registered

Metadata (key=value)

Koordinatsys. plan	Koordinatsys. höjd

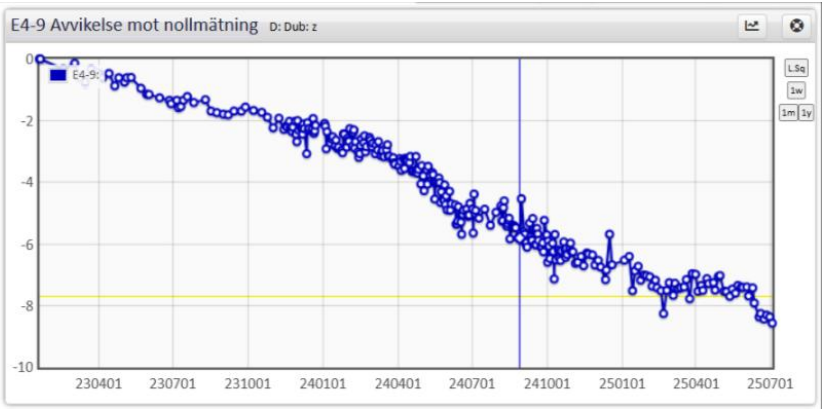
Links

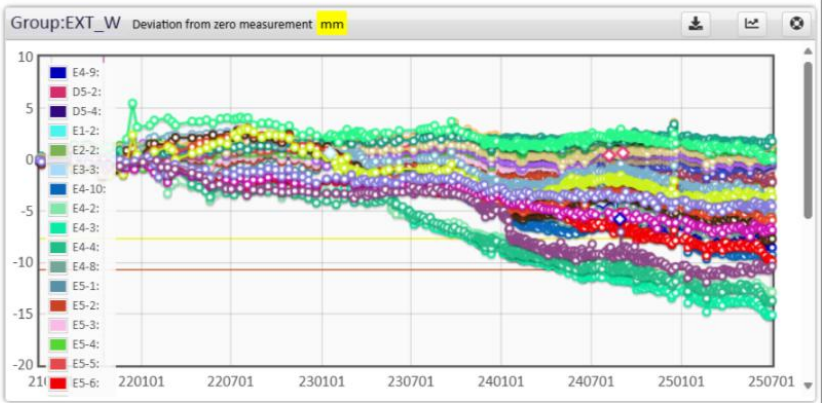
Link to Projektnav map: E05: 57.69577707, 11.98421769

Link to external maps: Google Maps | Geo: URL

Larm/Rict/Green values Larm mot Measures 0

Alarm.Nr	Naming





DO WE HAVE A DIGITAL TWIN?

A geotechnical digital twin is a dynamic, virtual representation of a geotechnical system (soil, rock, and associated structures) that is continuously updated with real-world data, including sensors, measurements, and models, to reflect its current and future state.

It combines 3D models of geology and structures with real-time data and computational models to enable simulation, analysis, and decision support throughout the entire lifecycle of a project.

Source: Various….

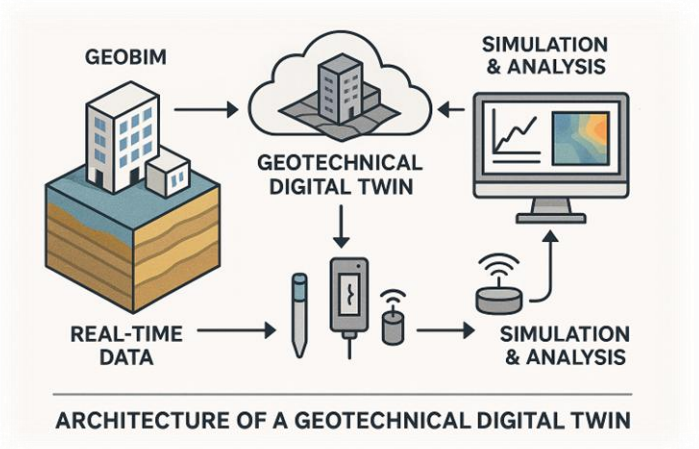


Figure by Copilot

DO WE HAVE A DIGITAL TWIN?

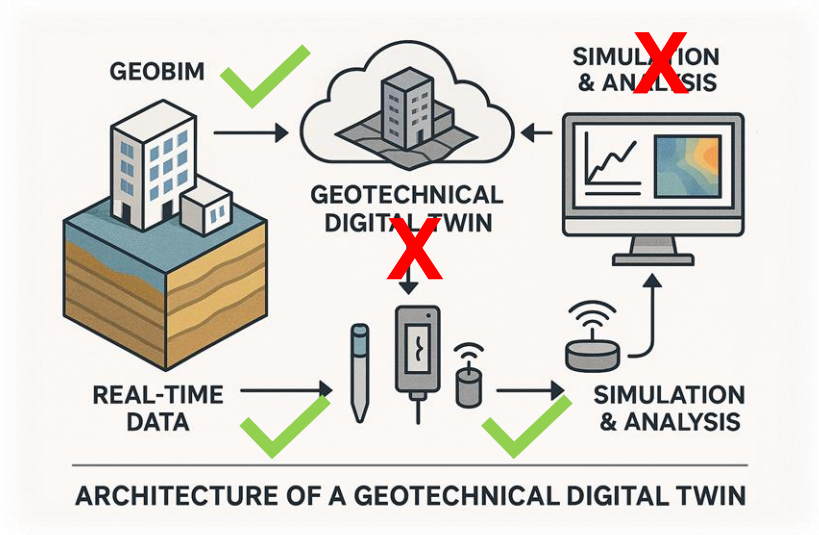


Figure by Copilot

- Structured data flow
  - all subsurface disciplines
  - geotechncial structures (objects)
  - monitored data (time series)
- In the same database
  - Field and lab data
  - 3D models
  - Geotechnical structures
  - Monitored data

=> NO

FUTURE WORK

- Develop a data pipeline to collect and store sensor data in real time
- Implement an analysis engine:
  - Signal processing (filtering, noise reduction)
  - Trend analysis and anomaly detection
- Connect to geotechnical calculation models
  - Plaxis, GeoStudio (SLOPE), inhouse applications
- Automated feed back loop
  - Define rules and triggers
- Predictive functionality
  - ML to predict future conditions (stability, settlements)
  - Simulate scenarios based on incoming data and historical trends
  - Integrate with decision-support systems for proactive risk management

Small pilot project

THANKS

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