Use of the 3D Geological model with SCL Tunnelling in Crossrail Farringdon Station

Dr. Sauer & Partners

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AGENDA

- Farringdon Station overview.
- The Geology of Farringdon Station.
- Evolution of Farringdon 3D Geological Model.
- Integration of tunnel excavation data in the 3D Model.
- Faults in Farringdon Station.
- Case Study: Wraparound PL2RC.
- Conclusions.
Farringdon Station

- In the heart of Crossrail
- Connecting 3 Networks
- Receiving 4 TBMs
- Constructed using Sprayed Concrete Lining (SCL) techniques
The Geology of Farringdon Station.

PTW Enlargement

PL2RC

CH1 Pilot Tunnel
Evolution Farringdon 3D Geological Model

- **2009:** Initial 3D geological model for Farringdon Station by BGS.
- **March 2013:** DSP join the GSI3D consortium.
- **April 2013:** DSP/BFK receive the original Farringdon model from BGS.
- **April – May 2013:** 3D model updated with additional GI data.
- **May 2013 – Today:** Tunnel excavation data is being incorporated.
Integrating tunnel excavation data

- **Ground observation.**
- **Geological sketch.**
- **Geotechnical log.**
- **Data input in GSI3D.**
Integrating tunnel excavation data
Integrating tunnel excavation data
Faults

- Farringdon Fault.
- Smithfield Fault.
- St. John Street Fault.
- Chaterhouse Fault.
Faults

- Farringdon Fault.
- **Smithfield Fault.**
- St. John Street Fault.
- Chaterhouse Fault.
Faults

- Farringdon Fault.
- Smithfield Fault.
- St. John Street Fault.
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Faults

- **Farringdon Fault.**
- **Smithfield Fault.**
- **St. John Street Fault.**
- **Chaterhouse Fault.**
Faults

St. John’s Street F.

Farringdon F.

Smithfield F. PTE Invert
St. John’s Street Fault
Sand Lenses and Faults
Case Study: Wraparound PL2RC

Target:

To design & Construct a Wraparound without any rebar or thickening to connect SCL and TBM works

SCL Risks:

Sand Lenses and Farringdon Fault
Case Study: Wraparound PL2RC

- Integral Part of Site Supervision
- Constantly updated with additional excavation data
- Enables predictions of increasing accuracy

Prior to 2009
- Third Parties Historical Data
- Crossrail Specific Site Investigation

2009
- 3D Geological Model British Geological Survey (BGS)
- Additional Data from BFK I&M Drilling
- Shaft Excavation Data

2012-2013
- 3D Geological Model DSP / BFK
- Increasing Knowledge
- Increasing Confidence

April 2013 Onwards
- Face Mapping Data
- Geological Prediction for Future Tunnels
- In-Tunnel Probing
- Cycle of Risk Reduction
Case Study: Wraparound PL2RC

- Predicted Stratigraphy (3D Model)
  - Tunnel Meters
  - Elevation (mATD)
  - 95, 90, 85, 80

- Actual Stratigraphy (Face Mapping)
  - Elevation (mATD)
  - 95, 90, 85, 80

- Diagrams showing geological strata with color-coded layers:
  - Upper Mottled Beds [UMB]
  - Laminated Beds [LTB]
  - Lower Shelly Beds [LSB]
  - Lower Mottled Beds Clay and Sandy Clay [LMB]
  - Sandy GRAVEL/GRAVEL
  - Upper Formation [UF]

- Design phase
- Construction Phase

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Case Study: Wraparound PL2RC

- PL2RC Wraparound
- Westbound TEM
- Transition
- CP1

Graph showing measured and predicted data with markers for M1 to M8, showing a 10 mm difference between the two.

Settlements induced by PL2RC excavation, with readings from 16/08/2013 and 3D FEM prediction.

Distance from PTW Axis [m]
Use of 3D Geological model with SCL tunnelling to manage the geotechnical risks

Enabled an optimised design

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4 months gain
Conclusions

- Significant update of the 2009 3D Farringdon model
- Innovative combination with SCL tunnelling
  - “Live” model – Geo database
  - Predictions ahead of Tunnelling
  - Tunnel excavation data back in the model
- Increased confidence in the anticipated conditions
- Optimised Tunnel design
- Assisted decision making
100 Great Geosites Initiative

‘Celebrating the unique geo-heritage of the United Kingdom and Ireland’

Farringdon Station LU in the 100 Great Geosites list section: *Industrial and Economic Importance*
Acknowledgements