D&B versus TBM

– some case stories

TBM Applications II – Bergen, June 6th and 7th
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Case stories – Two different Projects

Considerations regarding excavation method:

- New double track railway lines in the West Corridor
- The Follo Line Project
Tunnel concept

One double track tunnel
Exit every 1000 meter
One double track tunnel
Parallel escape tunnel
Cross connections every 1000 meter
Two single track tunnels
Cross connections every 500 meter
Two single track tunnels
Cross connections every 500 meter

For railway tunnels the choice must be based on:
• Safety
• Requirements for Reliability, Availability and Maintainability
• Length of the tunnel
• Geological conditions
• Topography
• Cost
New double track railway lines west of Oslo
A densely populated area
D&B from three access points
TBM from one access point
TBM vs D&B

Results of the Calculations

• TBM 600 – 700 mill NOK more expensive than D&B
• One year longer excavation period for TBM than for D&B
• Less disturbances of the neighbors alongside the tunnel section by using TBM, but more disturbances in each end of the tunnel/ access tunnel

JBV decided to excavate the tunnel by D&B
Ikke gehør for borekrav

Boring bør utredes bedre

Lover billig boring

Presset til sprengning

Vurderer boring likevel

Fortsetter tunnelkamp
3rd party verification

Conclusion from SINTEF
Confirmed the results regarding cost and schedule made by JBV

Final decision: Excavate the tunnel by D&B
The Follo Line Project

- An early consideration about excavation method
- Decision of a tunnel concept with two separate tunnels.
- Consideration of excavation method based on environmental benefits, cost and schedule
Complicated crossings and restrictions in the northern part of the tunnel section
Excavation method for the northern part of the tunnel

- The access tunnels and the relocation of the Alna river tunnel cannot be excavated by TBM
- Difficult access for a TBM for excavation of the inbound Østfold Line
- Using TBM for the Follo Line tunnels in this section: This would have been the last part of a 10 km long TBM section and on critical path for the project

1.5 km tunnel – A separate contract
Excavation by Drill & Blast in combination with Drill & Split
Excavation method for the northern part of the tunnel

- A grid of holes are bored, as many as 500 within a cross section of 68 m²
- Distance between the holes is approximately 0.4 meter
D&B versus TBM for the rest of the tunnel

**Drill & Blast:**
- Seven access points
- Many located in densely populated areas

**TBM:**
- One access point in connection with one large rig area.
- Few neighbors
The excavation methods for The Follo Line Project

- 1.5 m excavated by a combination of Drill & Blast and Drill & Split methodology
- 18.5 km excavated by four TBMs from one single access point
Why TBM?

- In theory identical cost and schedule for the two alternatives
- One compact rig area instead of seven different rig areas
- Difficulties of getting approval for some of the seven access points related to D&B in due time
- Transportation of all the excavated material on belt conveyors out of the tunnel
- Environmental benefits regarding
  - Compact rig area with many “in house” activities
  - Reuse of excavated material at Åsland
  - Direct access to E6 for TBM
  - No transport on local roads or within densely populated areas
  - Segment production at site reduces the transportation
- Less resources in the client’s organization to follow up
- Reintroduction of TBM as a excavation method in Norway
The excavation of the tunnels must be prepared for the geology and for the crossing of several weakness zones

- Predominantly Precambrian gneisses – banding and lenses of amphibolite and pegmatite
- The rock mass is in general homogenous, abrasive and strong. Mean Uniaxial strength is 150 MPa
- Moderate jointing, but some groups of fractured zones intersect the tunnel and may act as drainage channels
- Average overburden approx. 80 meters – variations of between 5 to 170 meters
- Sedimentary shale in the northern part
Tailor made TBMs for extreme hard rock conditions

- Diameter: 9,960 meter
- Weight: 2400 tons
- Number of cutters: 71
- Installed power: 6200 kW
- Expected daily progress: 12 – 15 meter
- Start-up of the four machines between September and December 2016
Why didn’t we let the marked decide?

Important to make a decision about excavation-method before production of ITTs

- More efficient to focus on one method
- Contract strategy might be different for the two methods
- Different pre-works
- One strategy = preferable for the contractors
Conclusion

Different projects with different parameters

Decision of different excavation methods
Thank you for your kind attention 😊

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