

# EPC TBM Follobanen

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# The Follo-Line project

*The largest infrastructure project in Norway*



- 22 km double railway track, high-speed, between Oslo and Ski
- New Ski station, twin tunnel and connection to Oslo Central Station
- Reduces travel time from 22 to 11 min for thousands of daily commuters
- Five EPC-contracts
- Commissioned by the Norwegian government's agency for railway services (Bane NOR)

# Scandinavia's longest railway tunnel

*AGJV to construct the main part of the Follo Line tunnel*

- Two 20 km single track twin tunnels
- AGJV excavated 18,5 km by using four Tunnel Boring Machines (TBMs)
- AGJV's pre-casted concrete segments mounted on the walls
- Excavation of transport and escape tunnels and assembly hall
- Installation of railway systems
- Start in 2015, to be completed by 2021, while the entire infrastructure will start operation phase at the end of 2022



# About Acciona Ghella Joint Venture

*Constructing the Follo Line twin-tunnel*

- The Spanish company Acciona and Italian Ghella have joined forces and established AGJV
- Commissioned by Norwegian government's agency for railway services (Bane NOR) to construct the main part of Follo Line tunnel
- Contract worth NOK 8.7 billion (1 billion euro)



# About Acciona and Ghella

*International companies with extensive infrastructure and tunneling competence*



- Spanish global infrastructure and renewable energy group
- Roots from 1930s – Acciona founded in 1997
- Listed on the Madrid stock exchange
- Revenue 6,544 million euros in 2015
- About 32 000 employees
- Present in more than 30 countries around the world
- [www.accionia.com](http://www.accionia.com)



- Italian construction company with expertise in tunneling and underground work
- Founded in 1894, family-owned
- About 2 500 employees
- Projects and experience from a number of countries in Europe, Australia, New Zealand and Central & South America
- [www.ghella.com](http://www.ghella.com)

# Excavation of tunnels and hall

*Drill and blast of adit and transport tunnels and assembly hall from Åsland in first phase*



# Why use TBMs on Follo Line?

*TBMs makes a robust tunnel with few disturbances*

- The length and complexity of the tunnel
- Less noise and disturbances
- Less rig areas at surface
- Good pace in the excavation
- An instantly watertight tunnel
- Tunnel lifetime – 100 years
- <https://www.youtube.com/watch?v=FVAaspPunc>



# Tunnel Boring Machine

*Four machines excavates the Follo Line twin tunnel*

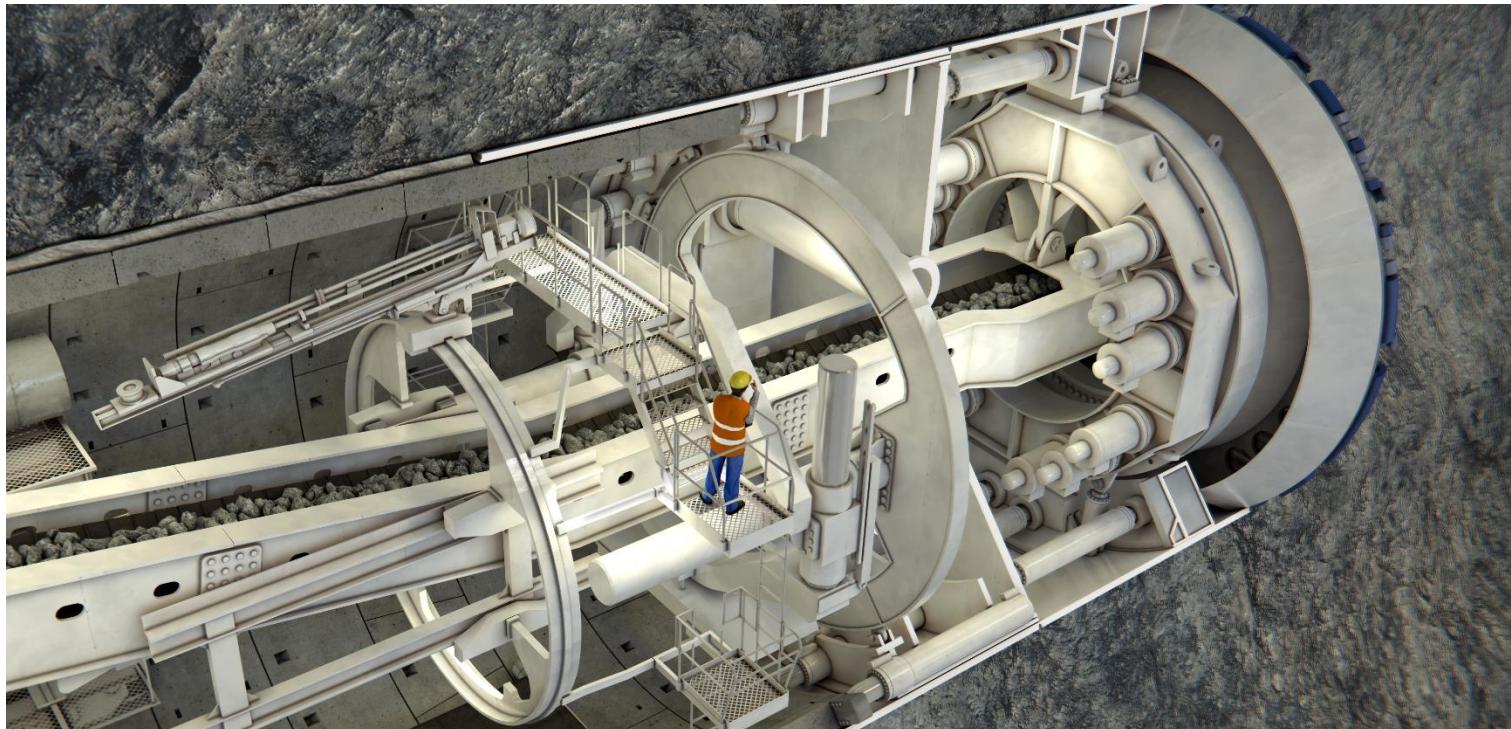
- Assembly from spring 2016
- All four TBMs started during autumn 2016
- Diameter machine/tunnel: 9,96 m/8,75m
- Length of machines: 150 m
- Weight: 2400 tons
- Installed Power: 6200 kW
- No of Cutters: 71
- Average excavation speed: 12-15 m/day
- Made by the German company  
Herrenknecht
- 9 mill tons excavated



# How a TBM operate?

*Excavating the rock and lining the tunnel*

- Assembled and disassembled at the factory
- Assembled again inside the tunnel, before excavation
- Excavate rock by using cutter disks
- The machine use a gripper system against the wall to move forward
- The excavated rock will be transported away by a conveyor
- The rear section of the TBM installs the concrete lining
- <https://youtu.be/XQ6lz4rcSFA?t=216>





# Concrete element production

*On-site factory*



- Concrete factory for pre-casting – segment storage and masses

Segments Tracking System implemented to monitor  
the quality of the tunnel lining elements along their  
life cycle, from production to final installation



Total segments casted: 164.959

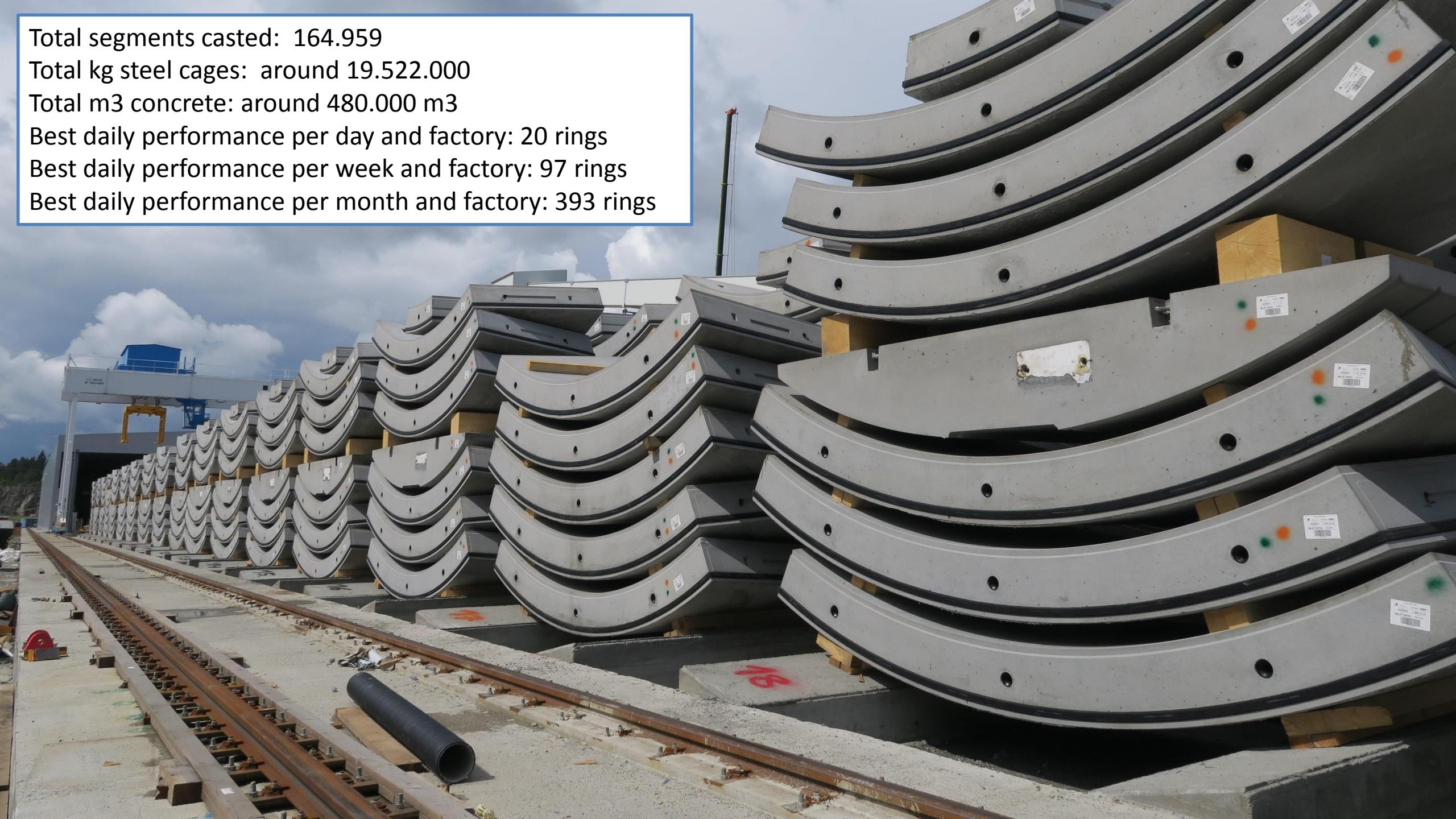
Total kg steel cages: around 19.522.000

Total m<sup>3</sup> concrete: around 480.000 m<sup>3</sup>

Best daily performance per day and factory: 20 rings

Best daily performance per week and factory: 97 rings

Best daily performance per month and factory: 393 rings



# Lining the tunnel

*Precast concrete segments mounted on the wall*



- The rear section of the TBM installs the concrete lining creating the reinforced tunnel wall
- The concrete segments are produced on a factory on the site

# Precast walkways



# Cross Passages



*Lining Transitions*



*Fit Outs*

# Slab Track

## *Scope of Works*



- Track assembling and positioning
- Concrete slab pouring
- Rail welding
- Rail grinding

# Railway systems

## *Scope of Works*



- Traction Power supply
- Overhead contact line
- Infrastructure Power Supply
- Low voltage system
- Ventilation system
- Fire fighting system
- Doors and airlocks

# Juridisk/kontrakt i EPC TBM Follobanen

## Kontrakten

- NTK – Fisken på land?
  - Ingen grunnforholdsbestemmelse
  - Ingen EU-standarder
  - Lite kjent i bransjen
  - Gjør det egentlig noe?
- Dagmulkt milepæler og på andre forhold
- Global cap på 5%
- Reklamasjonsperiode: 10 år på tunneler, 5 år på resten
- Kompensasjonformat:
  - Hovedsakelig rundsum + formler for grunnforhold
  - Endringsarbeider som rundsum eller på regning (opptil byggherre)
  - Vesentlig grad av forhåndsdefinerte rater for regningsarbeid



# Juridisk/kontrakt i EPC TBM Follobanen

## Grunnforhold

- Faktiske avvik:
  - Forhåndinjeksjon (Vanninnntrengning)
  - Bergsammensetning
- Formel for fremdrift og forbruk av kuttere
  - “Brulandformelen”
  - Geologisk informasjon og tolkning av denne



# Juridisk/kontrakt i EPC TBM Follobanen

*Eksempler på endringsdiskusjoner*

- Frost
- Nødbelysning
- Betongstøp
- Lagringsplasser/riggplasser
- Forberedende tunnelarbeider
- Jernbaneteknisk



# Juridisk/kontrakt i EPC TBM Follobanen

## *Fremdrift og annet*

- Hvem eier flyten?
- Frister for tilgang til lagringsplasser/riggplasser
- Forsinkelser/hindringer på tilgrensende EPC-er
- Arbeidsrett, både kollektivt og individuelt
- Konkursrett
- Obligasjonsrett mht UE-tvister
- Tekniske krav i forskrift (elektrisk, miljø, sikkerhet)

# Juridisk/kontrakt i EPC TBM Follobanen

## *Oppsummering / diskusjonspunkter?*

- 95% av diskusjoner om kontrakt i et prosjekt handler ikke om Conditions of Contract?
- Eksterne juridiske rådgivere bør ha god teknisk og kommersiell forståelse
- Hvordan unngå at konflikter oppstår/utvikles?
  - Hvor tidlig involveres entreprenørens kompetanse?
    - Kan redusere risiko
    - Kan redusere byggekost
    - Kan redusere konfliktpotensial
  - Optimaliserer partene sin egen kontraktsposisjon eller har de felles prosjektmål?
  - Er kompensasjonsprinsipper formulert som begrensninger eller som muligheter?
    - Deling av risiko?
    - Deling av gevinster?

# Juridisk/kontrakt i EPC TBM Follobanen

## *Oppsummering / diskusjonspunkter?*

- Hvordan unngå at konflikter oppstår/utvikles?
  - Hvor godt rendyrker byggherre EPC-rolen? Hvor godt gjør TE det samme?
  - Er det rom for å finne tekniske løsninger, eller er teknisk metode «satt»?
  - Usikkerhet i scope; hva er partenes kommersielle holdning?
  - Involveres konfliktløsningsråd fra begynnelsen eller bruker man meklere først når tvister oppstår?
  - Har partene grunnleggende skepsis til hverandre, eller velger de tillit?
    - Er det typisk norsk å være god, eller å tro at man er god?
  - Kommunikasjon; hvor villig er partene til å faktisk forstå hverandres posisjon?
  - Kommersielt utfall, hva er styrende: Byggherrens budsjett / Entreprenørens krav?