EARTH PRESSURE BALANCE (EPB) MACHINES

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BASIC COMPONENTS OF EPB TBM

- Air lock
- Bulkhead
- Cutting wheel
- Excavation chamber
- Mixing arms
- Screw conveyor
- Erector
- Belt conveyor
- Thrust cylinders
- Tailskin
- Backfilling
- Tunnel lining
EPB APPLICATION RANGE

Sieve Size

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<tr>
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<th>Clay</th>
<th>Fine</th>
<th>Medium</th>
<th>Coarse</th>
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<tbody>
<tr>
<td>Silt</td>
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<tr>
<td>Sand</td>
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<tr>
<td>Gravel</td>
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Grain diameter $d$ (mm)

Portion of grains $<d$ in % of the total amount

Sieve residue in weight %

- EPB
- Slurry Shield
EPB OPERATION MODES.
Closed-Mode, Semi-Open Mode, Open Mode.

Closed Mode

Semi open mode or Compressed Air Mode

Open Mode
SETTLEMENT CONTROL

TBM Advance – Speed of Propulsion

Speed of Screw Extraction

\[ P_{TBM} = P_W + P_E \]
EPB Principle

Water Pressure ($P_W$) <br>Ground Pressure ($P_E$) 

TBM Pressure ($P_{TBM}$) 

($P_{TBM} < P_W + P_E$)
EPB Principle

Water Pressure ($P_W$)
Ground Pressure ($P_E$)
TBM Pressure ($P_{TBM}$)

($P_{TBM} > P_W + P_E$)
Untreated soft clays
Metro Taipei 1992

EPB SOIL CONDITIONING
EPB Shield – Foam Injection Points
Testing of the Foam System in the Factory
Ground Conditioning

When a ground type does not have the ideal characteristics of fluidity and plasticity, ground conditioning can be used to modified & improve its ability to transmit the confinement pressure.

- **Coarse, frictioned soil**
  - Use foam & polymers

- **Silty sands**
  - Use foams

- **Clay adhesion & clogging**
  - Use foam and anti-clay additives

- **Very coarse, frictioned soil**
  - Use foam & special polymers + fine filler
Typical EPB Cutterheads for Soft Ground and Mixed Face
EPB Cutting Tools
Blocking of Disc Cutter in Cohesive Ground
Atmospheric Cutting Tool Replacement
Atmospheric Cutting Tool Replacement
Manlock (Airlock) for Hyperbaric Interventions
Manlocks for Hyperbaric Interventions
Types of Interventions

- Compressed air 0-3.6 bar, up to 4.5 bar in exceptional cases, short duration
  - decompression in TBM airlock
  - state of the art,
  - coverage by rules and regulations
- Mixed gas for short duration up to 6.0 bar
  - decompression in TBM airlock
- Saturation for long term interventions above 4.5 bar
  - above ground hyperbaric habitat
    (crew transfer shuttle)
Cutting Tool Wear Detection

- Direct Systems
- Wear monitoring for ripper tools
- Wear and rotation monitoring for disc cutters
- Hydraulic or electric wear monitoring of cutterhead structure

- Indirect Systems
- Data processing of excavation parameters
- Temperature monitoring
- Metal detection
Remote Visual Inspections
TBM: Hitachi Zosen 17.5m EPB (Worlds largest TBM)
PROJECT: Alaskan Way Viaduct Replacement, USA
CONTRACTOR: Seattle Tunnel Partners (Cragados – Tutor Perini)
TBM: 15.62m Herrenknecht EPB TBM
PROJECT: Galleria Sparvo, Italy
CONTRACTOR: Toto Costruzioni - Vianini Lavori – Profacta JV