



# TBM Selection and Specification

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## → TBM Selection and Specification

- TBM Selection - Challenges to be met
- TBM Technology
- Auxiliary Measures and Backup
- New Developments
- Summary of Selection Process
- Procurements
- Specification
- Conclusions



## → TBM Selection – Challenges to be Met

- Ground Movements
- Ground Water Control
- Excavation Stability
- Speed of Construction
- Dealing with the unforeseen
- Site Consideration
- Risk and Cost



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## → TBM Selection – Challenges to be Met

- Geology
- Tunnel Alignment
  - Design and build to negotiate both Vert. & Horiz. Alignment
- Tunnel Diameter
- Site Restrictions
  - Mechanisms to deliver, assemble and launch the TBM will impact TBM type employed
- Local Experience and Availability
- Project Time-frame
  - TBM can be customised exactly in accordance with projects specification

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## → TBM Selection - Challenges to be Met



KDB200 – Kowloon Southern Link



WIL 703 – West Island Line



DSD Tsuen Wan Drainage Tunnel



SMART Tunnel (Singapore)



CLP Castle Peak cable Tunnel

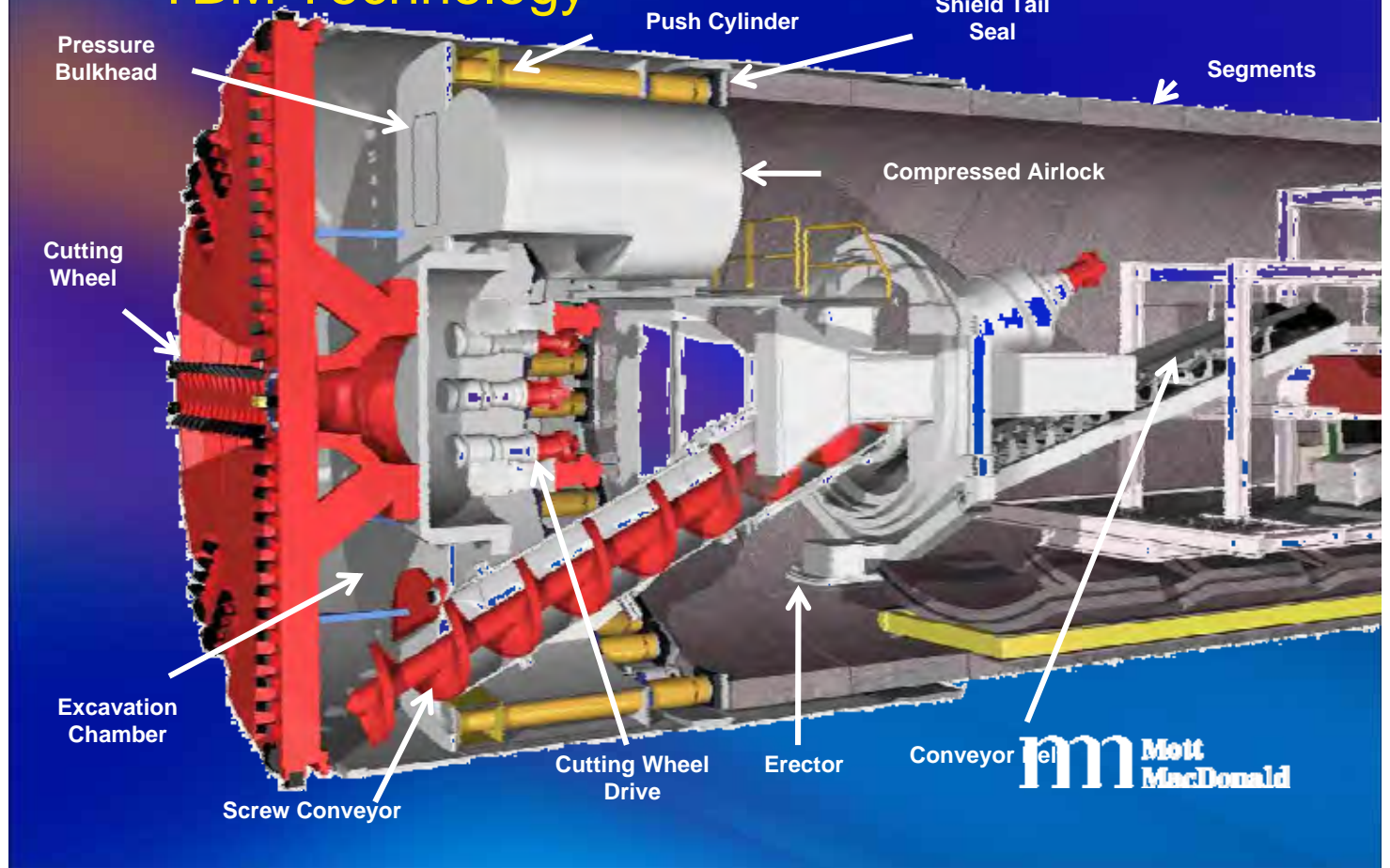
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# → TBM Technology



# → TBM Technology-Types of TBM



Open Mode TBM



EPB TBM



Slurry Shield TBM



Multi Head EPM TBM



Mixed Shield TBM

## → TBM Technology –Types of TBM

### 1. Open / Hard Rock TBMs

- Circular-Head Equipped with disc-cutters spaced in spiral fashion from centre to periphery
- Selected for tunnels in solid rock (UCS 50-300MPa)
- Provides no means of preventing groundwater entering the excavation



## → TBM Technology – Open mode TBMs

Open Face Shields

Gripper Shield

Segmental Shield

Double Shield



# → TBM Technology – Principal Types of TBM

## 2. Shielded TBMs

- Suitable for low face stability
- Pre-cast concrete segmental lining constructed directly behind the shield
- Different types of TBM shields to suit different ground conditions (i.e. Slurry Machines, Mixed Shields, Earth Pressure Balance Machines)
- Depending on ground conditions, Cutters discs or soft-ground picks and scrapers may be equipped accordingly



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# → TBM Technology – Shield TBM (Closed) Family

Closed Face TBM

Mechanical  
Support

Compressed  
Air Shield

Slurry Shield

Earth Pressure  
Balance TBM

Mixed Face  
Shield



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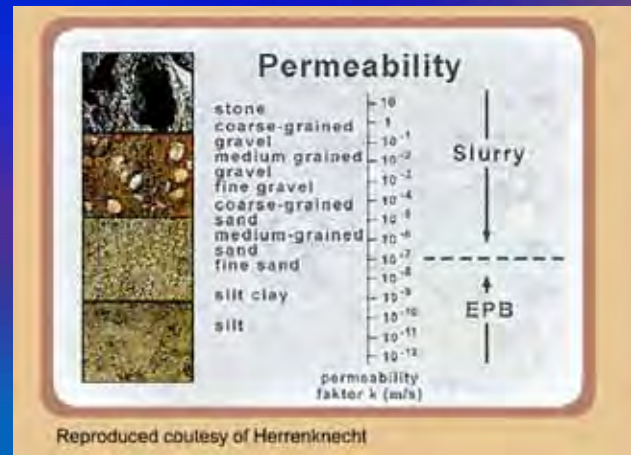
## → TBM Technology – Slurry or Earth Pressure Balance??

### Advantages of Earth Pressure Balance Machines

- In the event of face collapse, ground loss is limited
- Able to operate in open mode in firm ground
- Better production rates are possible
- Lower capital cost
- Smaller work Site and launch shaft

### Advantages of Slurry TBMs

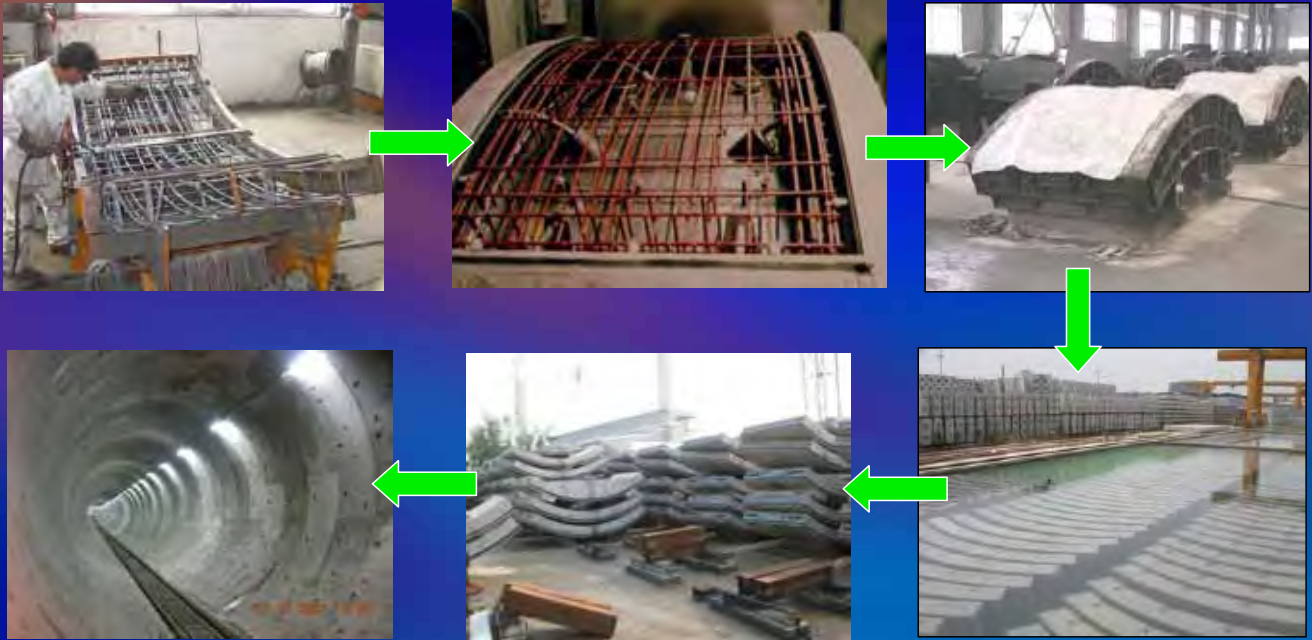
- Working pressure control is systematic
- Muck is only evident at the surface
- Less power requirement at cutterhead
- Less torque required
- Easier to understand and operate
- Reduced cutter wear, less frequent interventions



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→ Auxiliary Measures and Back-up -  
Precast segmental lining



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→ Auxiliary Measures and Back-up -  
Cutter Disc



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## → Auxiliary Measures - Site Constraints

- Segment Storage
- TBM Back-up
  - Slurry treatment plant
  - Compressed Air
  - Medical locks
  - Electrical sub-station
- Excavated material storage
- Cutter workshop
- Bentonite / conditioner storage

## → Auxiliary Measures and Back-up - Slurry Plant



## → Auxiliary Measures - Facilities

- Automatic guidance system
- Real time information
- Automated segment erection

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## → New Developments



Non-Circular Tunnel Boring Machine



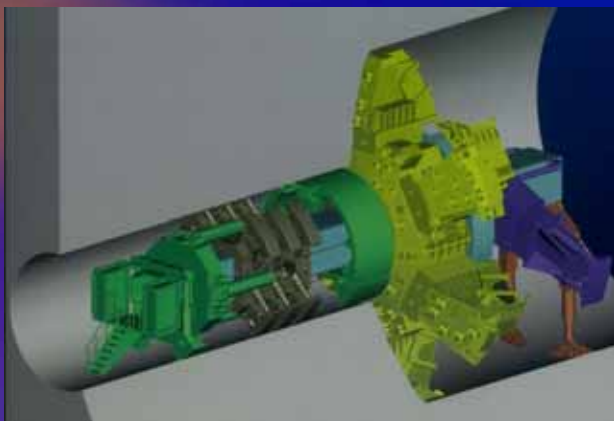
Non-Circular Section by Tunnel Boring Machine Technology



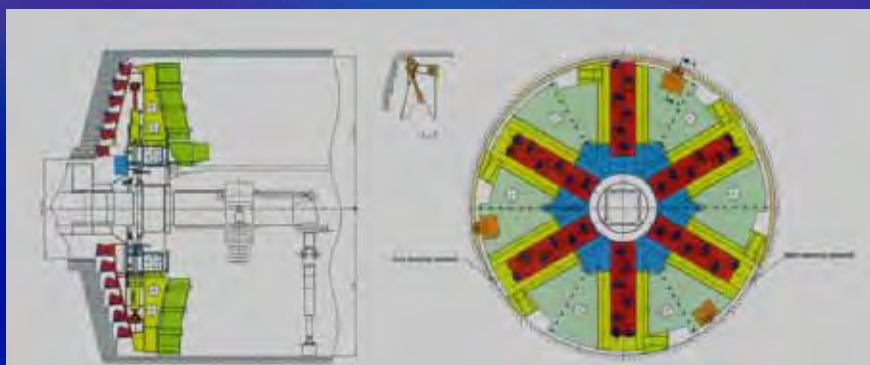
Example of tunnel cross section

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## → New Developments – Post Reaming



Tunnel Boring by Reaming - TBE



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## → Summary of Selection - Process

Is a TBM Required?

- Drive length / programme
- Ground conditions
- Ground water
- Environmental considerations
- Control of settlements
- Shape of the tunnel

## → Summary of Selection - Process

What type of TBM

- Stability of the face
- Ground conditions
- Site constraints
- Special features

## → Summary of Selection - Process

Are there remaining risks

- Unforeseen conditions
- Border line ground conditions

Is it clear what TBM should be selected?

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## → TBM Procurement

Level playing field

- State clearly the Employer's Requirements
- Consider base lining the principal assumptions
- To specify or not to specify
- Cash flow

Who should procure?

## → TBM Procurement

### Employer Procurement

#### Advantages

- Potential programme advantage
- Certainty of machine type
- Base lines a major risk
- Base lines functionality
- Greater certainty in costs/cash flow

#### Disadvantage

- Claims from Contractor on suitability
- Reduces contractor's innovation
- Suitability to final design
- Dictates method of working
- The client is sold a pup

## → TBM Procurement

### Contractor Procurement

#### Advantages

- Allows innovation in TBM design
- Best placed to manage risks
- Utilisation of existing plant
- Use of preferred supplier
- High level of experience
- Total sign-up to delivery

#### Disadvantage

- Long lead in times
- May seek to cut costs
- Cash flow



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## → TBM Specification

- Only use detailed specification if you are sure that it will meet the requirements
- Specification should not rule out and competition
- Clearly state Employer's Requirements
- Check that the Specification is not in conflict with base lined information
- Maintain options if compatible with approach
- Be mindful of Contractor's preference



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## → TBM Selection and Specification - Conclusions

- Knowledge of ground conditions is essential
- Knowledge of the possible impact of tunnelling is essential
- Be clear on what you are expecting the TBM to achieve
- Is your selection of TBM compatible with base line items
- Is your selection of TBM compatible with site constraints
- Determine who is best placed to procure the TBM
- Don't over specify



# TBM Selection and Specification

The End  
Thank You

