



South African National
Committee on Tunnelling

SANCOT SYMPOSIUM Johannesburg, 14th April 2026

Logistical challenges with long, relatively small tunnels

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Overview presentation

1. Hard rock TBM types
2. Impact on performance
3. Logistic chains
4. TBM/Tunnel design
5. Conclusions

TBM Types focused on hard-rock technology



Double Shield TBM



Single Shield TBM



Gripper TBM

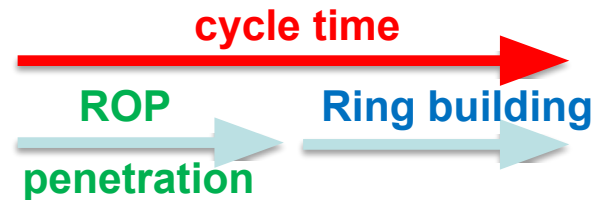
- Each TBM type has its own specific logistical challenges
- Each TBM type should be fully understood for assessing logistical challenges
- Logistics makes performance

TBM Types

Single-shield TBM



Single-shield TBM can only advance with segments consecutively being installed



Single-shield TBM stops during ring building

Cycle time provide time for logistics

TBM Types

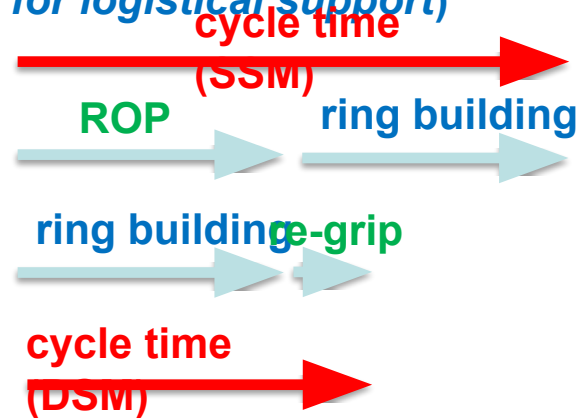
Double-shield TBM



Double Shield TBM

Double-shield TBM can advance with or without segments being installed concurrently (DSM) or consecutively (SSM)

(invert segment should always be used for logistical support)



The shorter the cycle time the more challenging for effective logistics

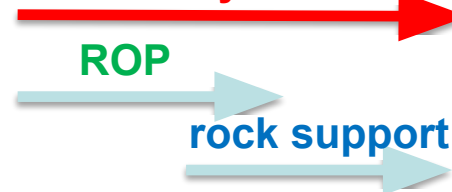
TBM Types

Gripper-TBM



Gripper-TBM uses rock support like NATM; advance and rock support mostly consecutively

(invert segment helpful for logistic support) **cycle time**

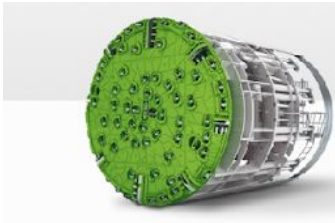


Gripper-TBM stops for re-gripping and irregularly for rock support

Unpredictability of rock support measure increases logistical effort

Impacts on Performance

ROP: TBM driven



mm/rev

logistics chain

Performance: Logistics driven



m/day

Depending on:

TBM specs

TBM operation

staff

Geology

Depending on:

TBM size/type

Tunnel length

site management

Staff

Geology

Comparison Single-shield and Double-shield TBM

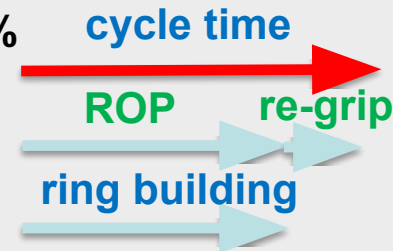
Single-shield TBM

Double-shield TBM

Normal rock



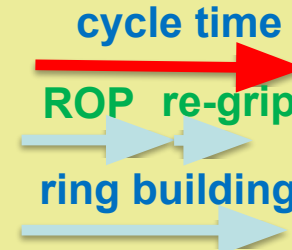
Delta: 25-65%



weak rock



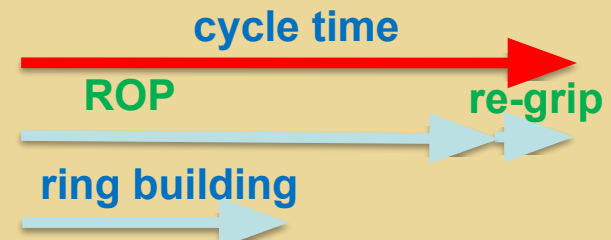
Delta: 20-30%



strong rock



Delta: 15-50%

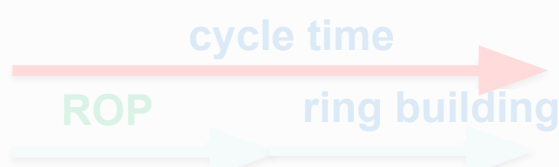


Comparison Single-shield and Double-shield TBM

Single-shield TBM

Double-shield TBM

Normal rock

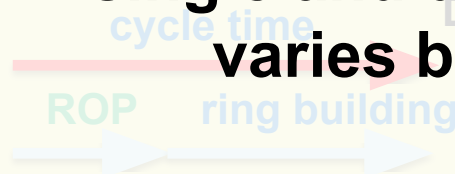


Delta: 25-65%

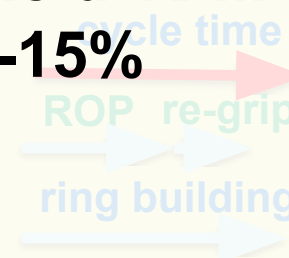


**Reality: performance delta between
single and double-shield TBM
varies between 5-15%**

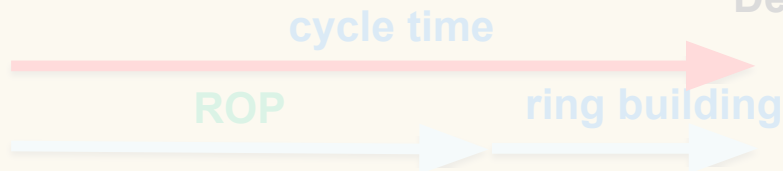
weak rock



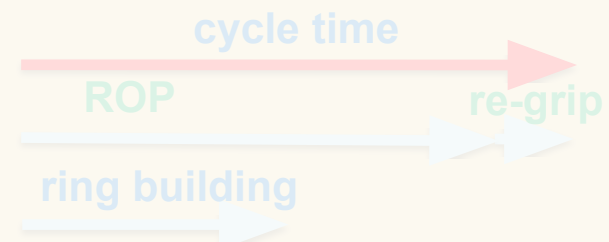
Delta: 20-30%



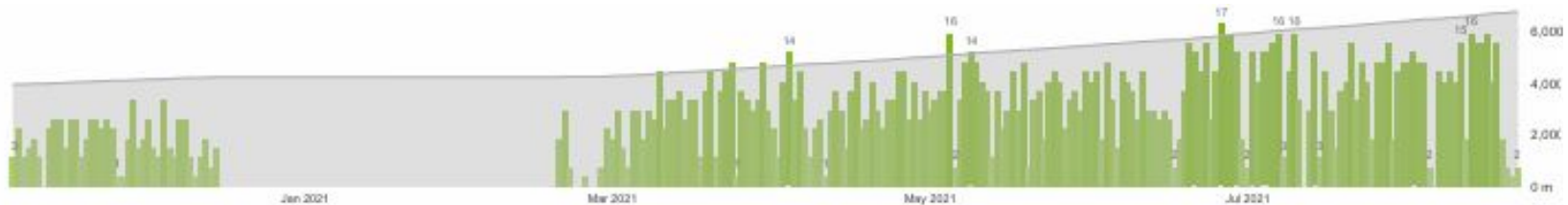
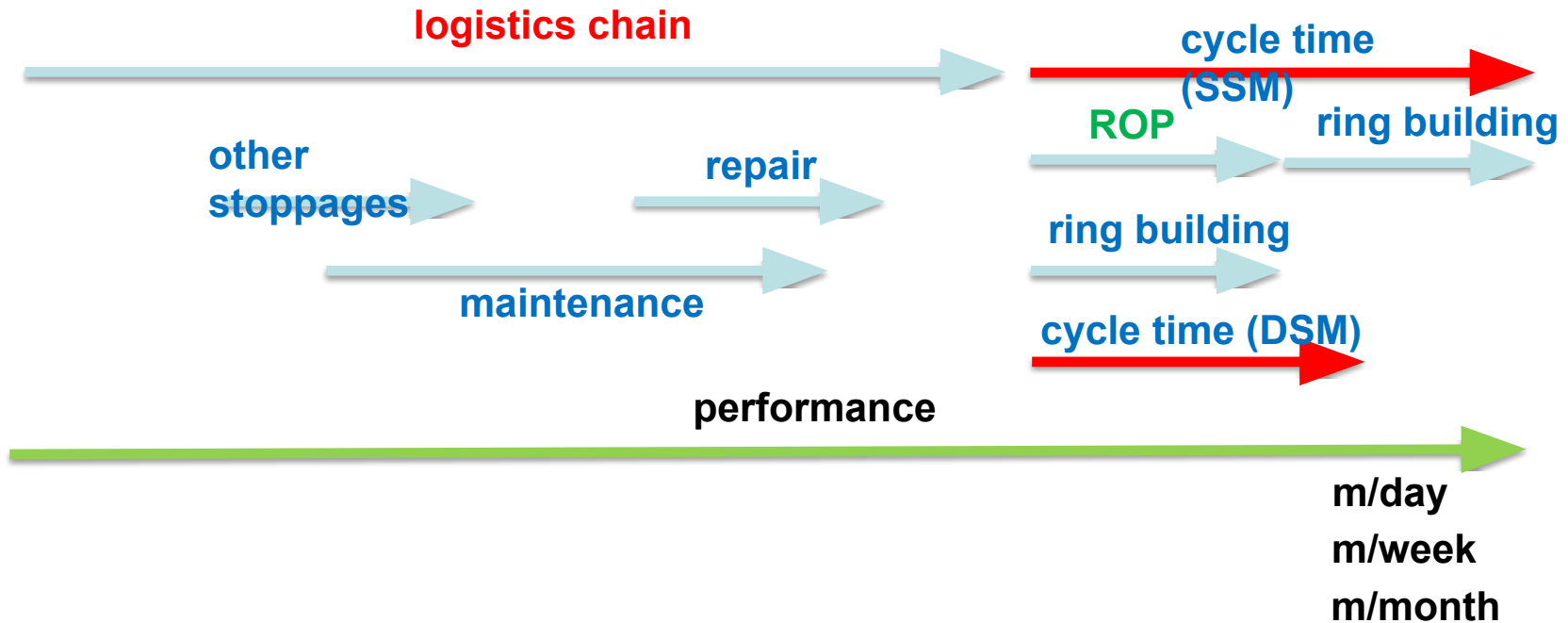
strong rock



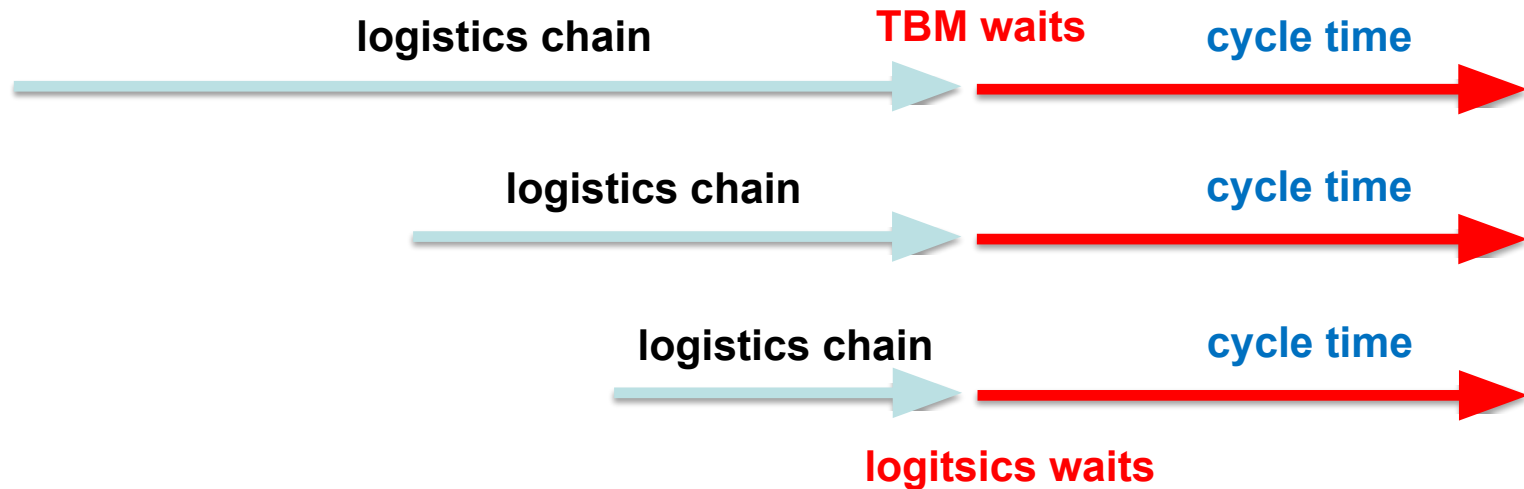
Delta: 15-50%



Impacts on Performance



Impacts on Performance



Logistics chain must be aligned with cycle time for most effective TBM performance

- The duration of the cycle time determines the duration of segment supply (by train or by MSV)
- The cycle time determines the number of trains/MSV or passing points in the tunnel
- The more trains/MSVs the higher the logistical effort and the equipment costs
- The size of available space within tunnel profile determines logistical possibilities
- The length of the tunnel determines the requirements for combinations of logistics chains/interfaces

Logistics TBM



Multiple Service Vehicle

Classical logistic components without space restrictions

Logistics TBM



Classical logistic components under space restrictions

Logistics TBM



Classical logistic components under space restrictions



Logistics TBM



Working under space restrictions

Logistics TBM



infrastructure in remote locations

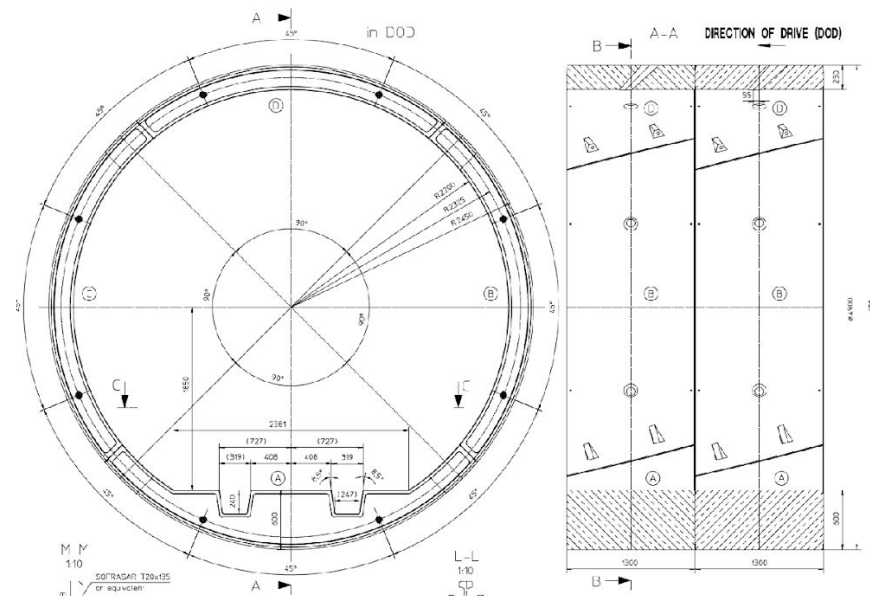
TBM/Tunnel design



Segment transport under space restrictions

TBM/Tunnel design

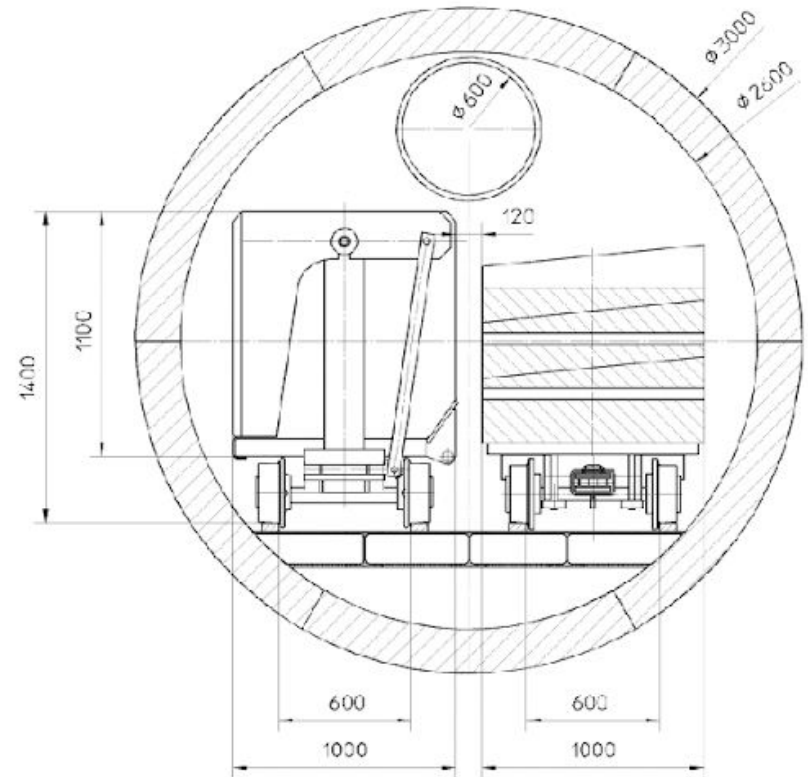
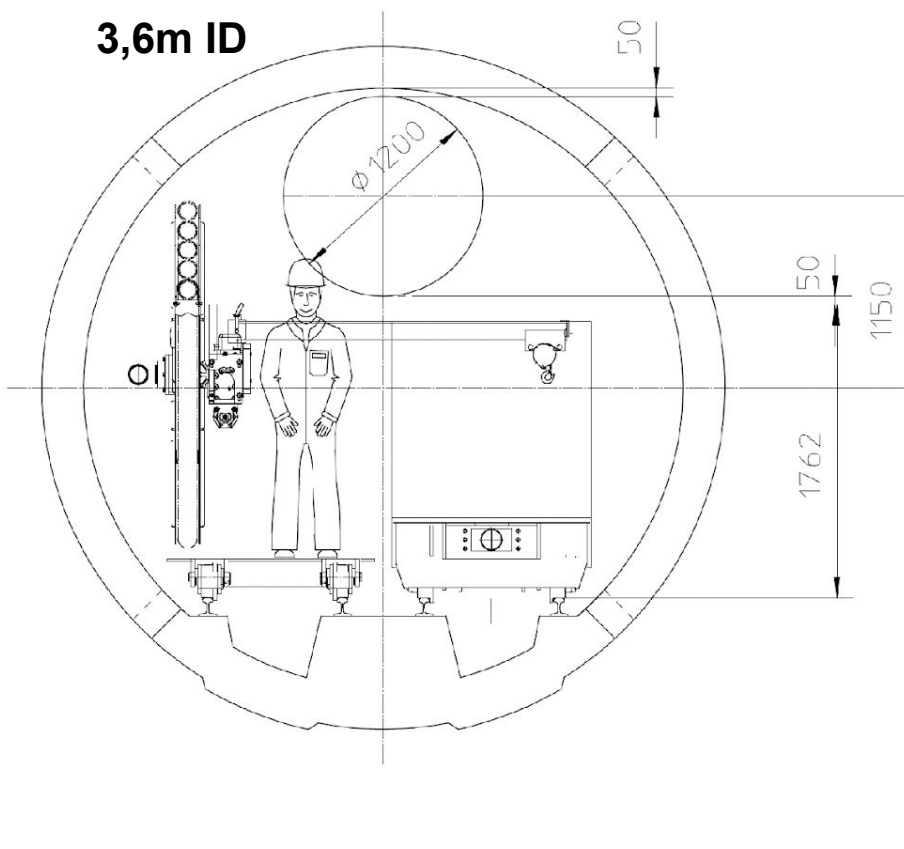
4-segment-ring



Small tunnel diameter: (+) fewer segments per ring; (-) confined working conditions.

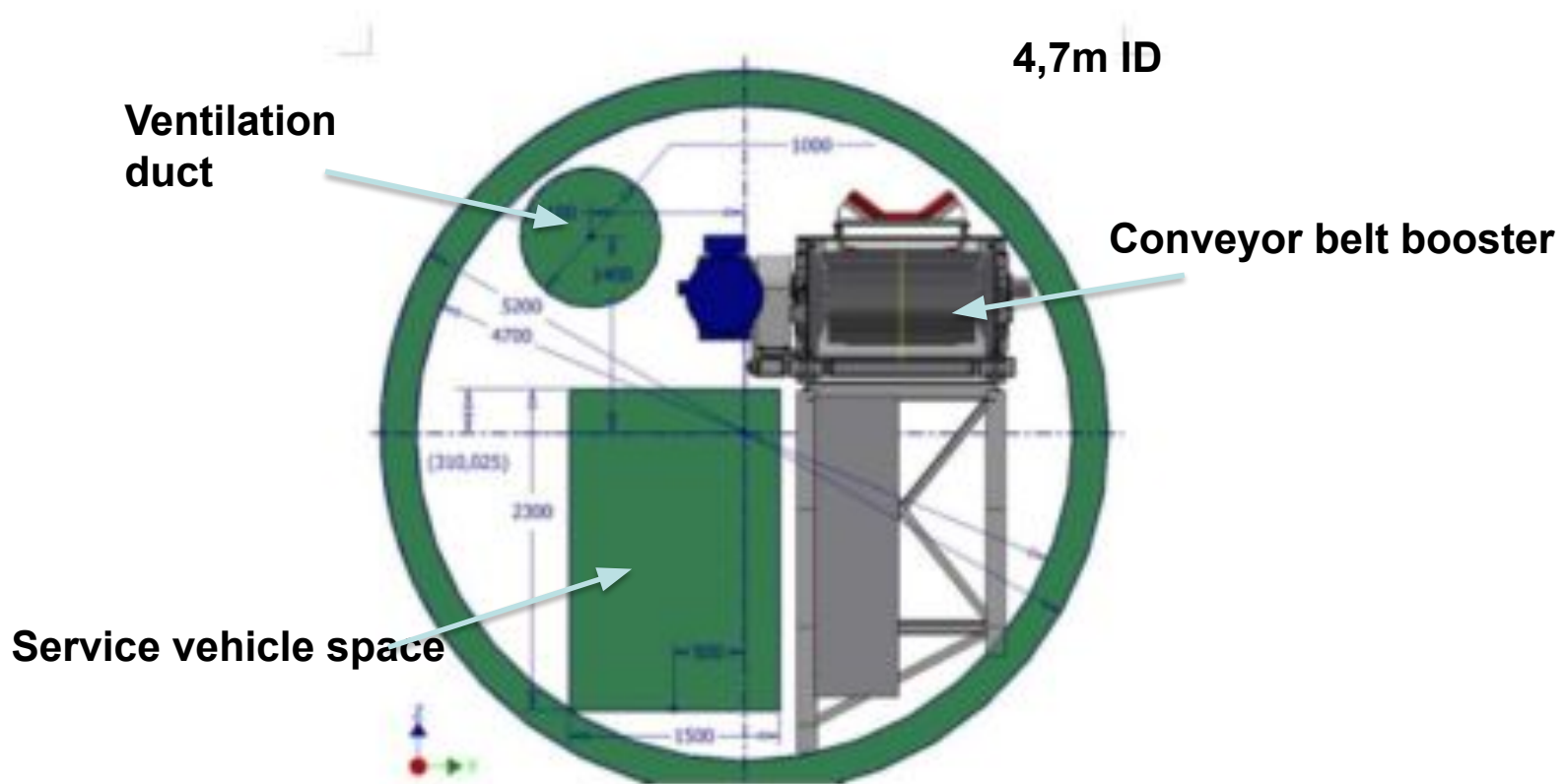
TBM/Tunnel design

3,6m ID



Safety distances between components must be maintained

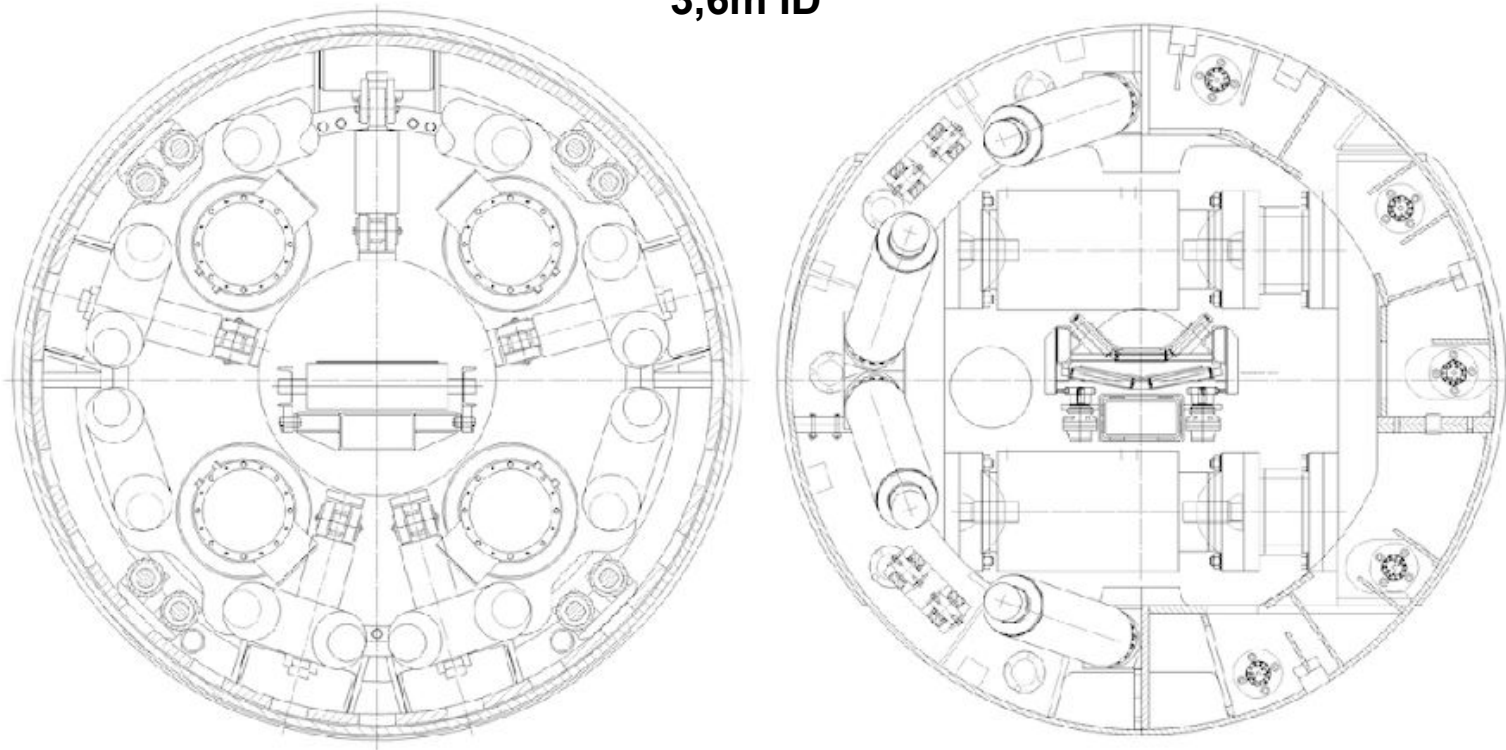
TBM/Tunnel design



Combining different logistical components gets bordered in small tunnels

TBM/Tunnel design

3,6m ID



Very restricted access to TBM components for repair/maintenance

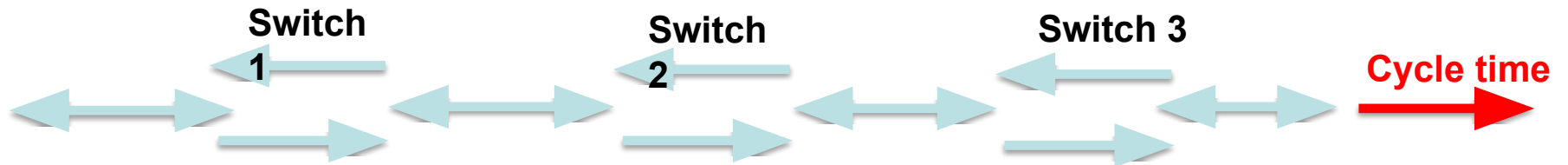
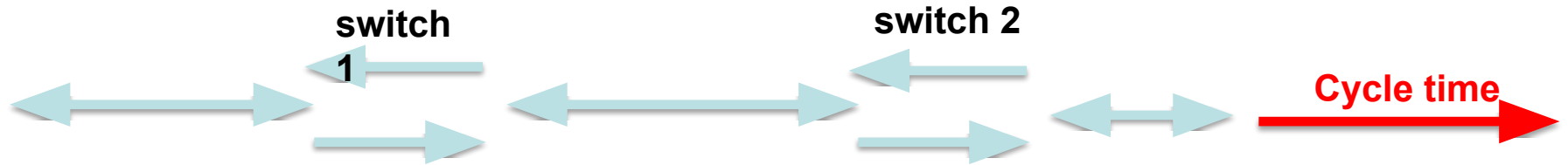
TBM/Tunnel design



Critical factors impacting on logistics:

- Number of interfaces (access tunnel, main tunnel, TBM)
- Every ramp for passing vehicles requires maintenance and poses a risk of accidents or injuries
- The smaller the tunnel profile, the more restricted the logistical possibilities
- The longer the tunnel the more sophisticated the logistics

TBM/Tunnel design



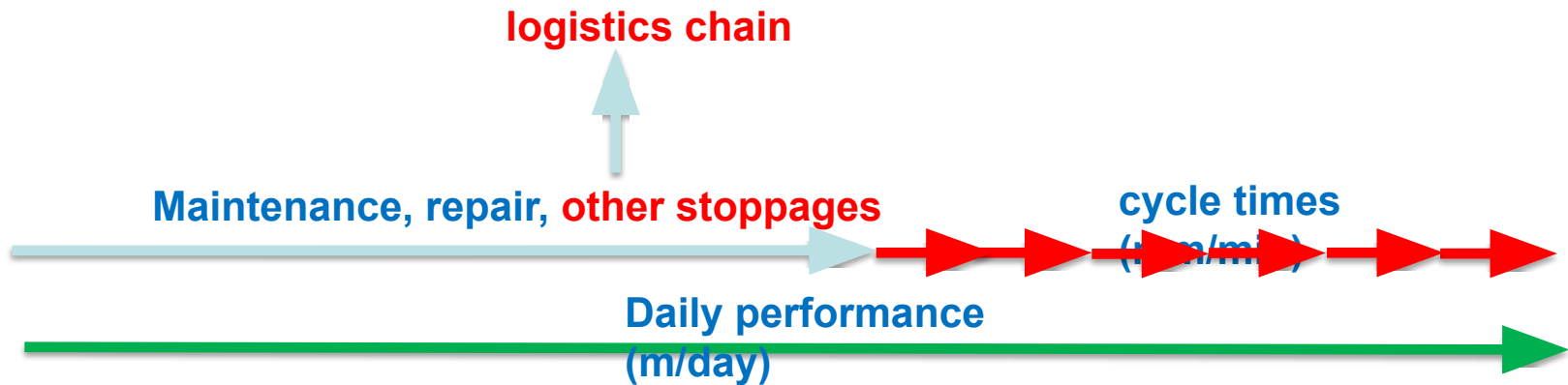
The number and placement of switches are crucial for effective performance

TBM/Tunnel design



The number and placement of switches are crucial for effective performance

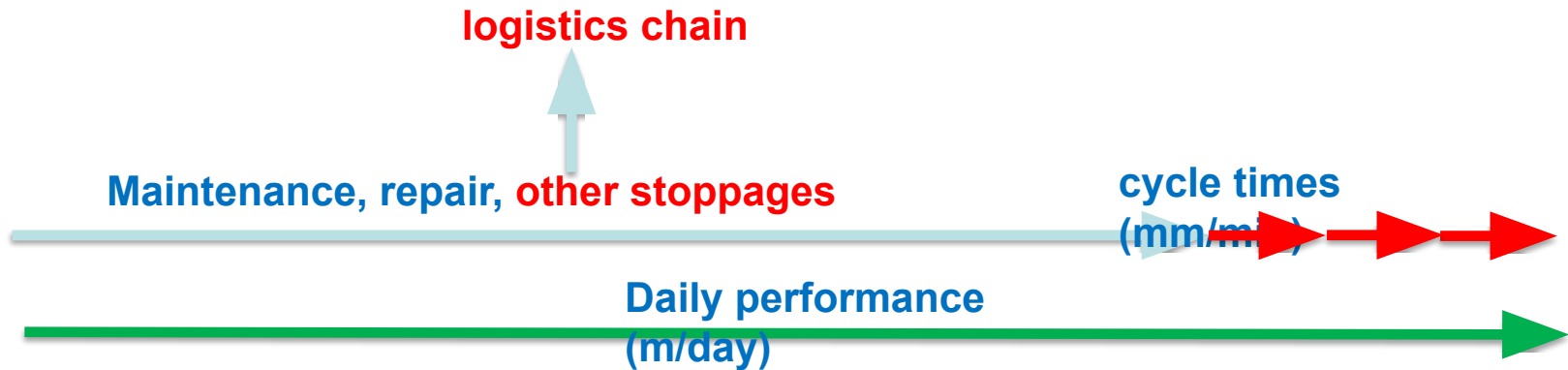
Conclusions



Daily performance determined by

- Working hours
- Relation between cycle time and non-cycle time
- Other stoppages (logistic chain: line extensions, consumables supply, segment repair, other construction works, ramp maintenance, rail maintenance, supply bottlenecks, accident, high water ingress, mucking, secondary grouting etc.)

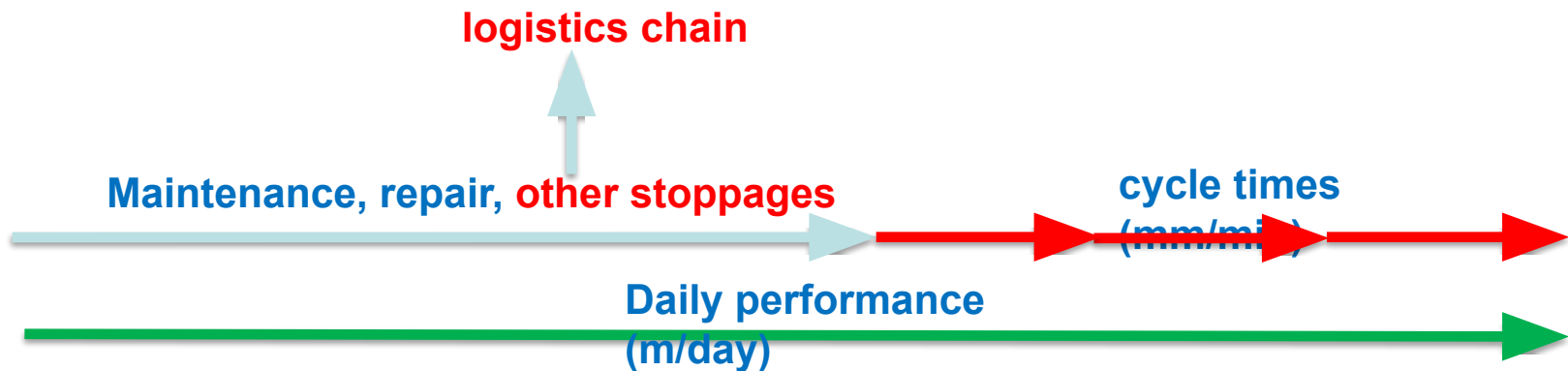
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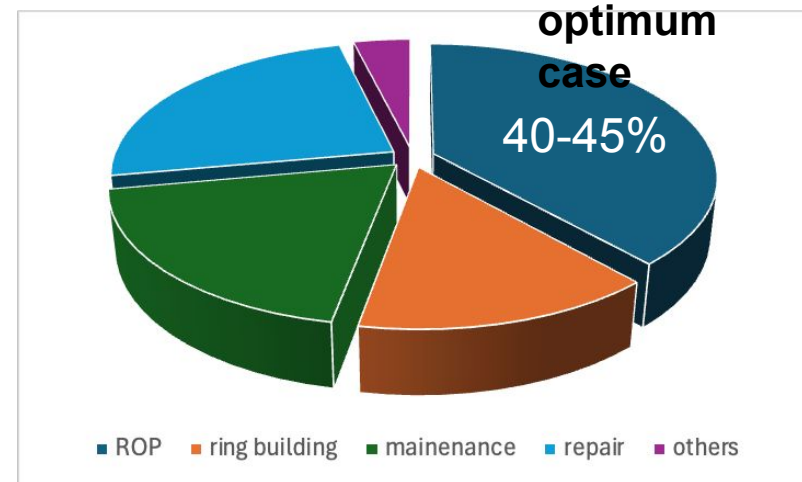
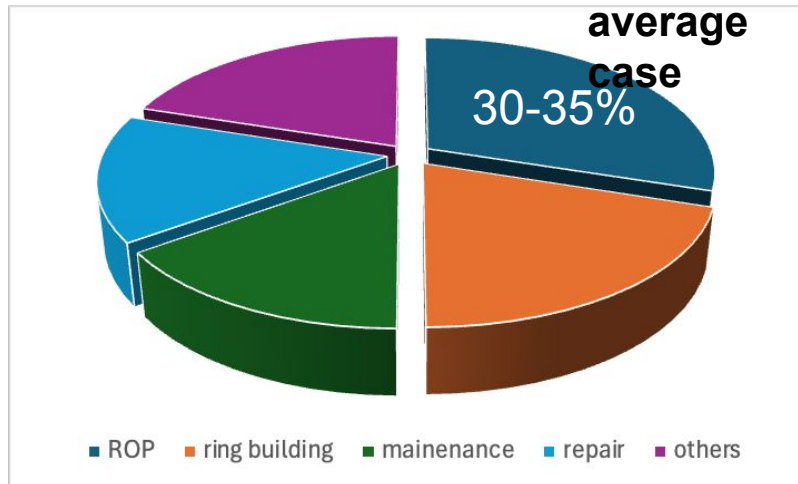


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Conclusions

possible tunnelling tasks distribution



- The proportion of ROP varies between 30-40% of the total tunneling time
- Relative Impact of small tunnel size 20-50%
- Relative Impact of tunnel length 15-30%
- Behind every slice of cake is the logistics chain
- **The optimized performance depends essentially on the implementation of the adequate logistics chain**



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**Thank you for your
attention !**