

CUTTERHEAD DISC ROBOTIC CHANGING SYSTEM « TELEMACH »



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Introduction



TELEMACH ROBOT

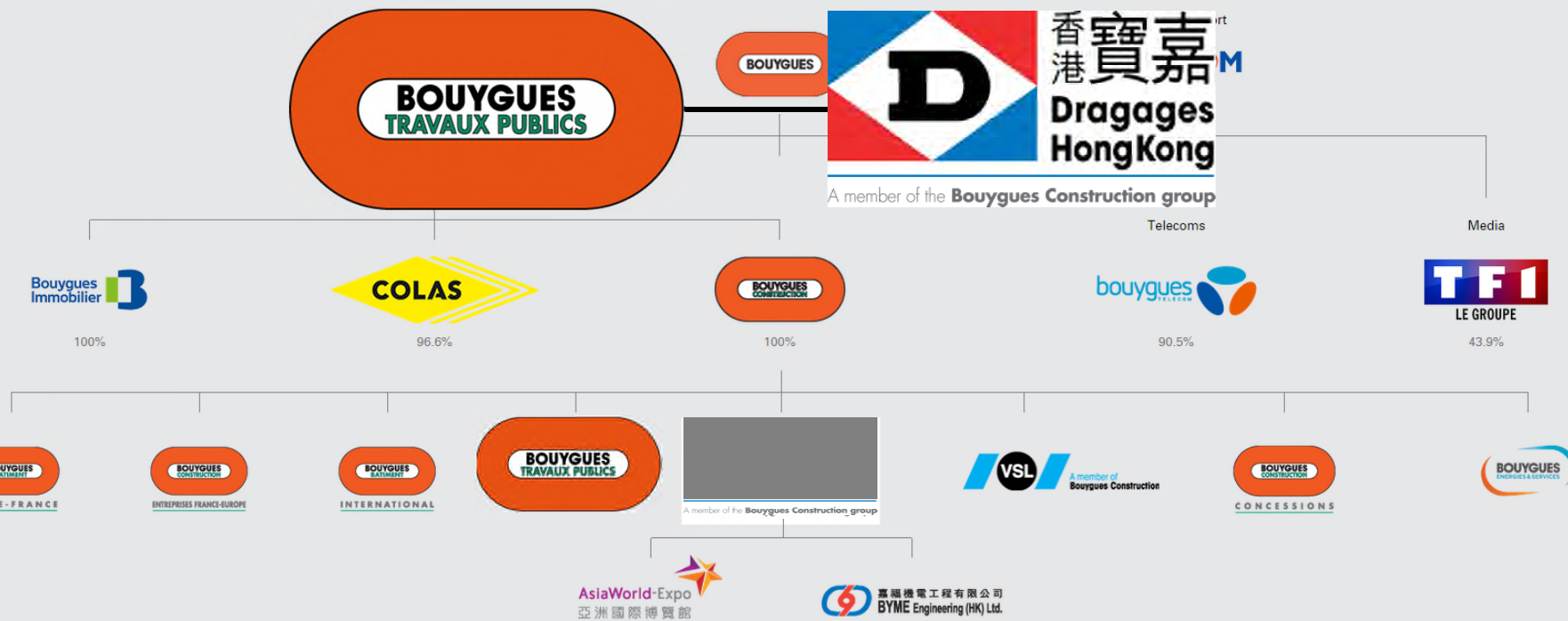


LIANTANG TBM CUTTERHEAD



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Stakeholders





TELEMACH DEVELOPMENT



FRANCE - Paris

HONG-KONG

**RESEARCH &
DEVELOPMENT**

**IMPLEMENTATION ON
SITE (3 TBMs)**

**Follow up &
improvement**

Feedback

1. Dragages HK & Liantang Contract 2 Project information

2. TBM Description

3. Cutterhead Disc Changing System innovation



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1. DHK & Liantang Contract 2 information



1

Dragages Hong Kong & Liantang Contract 2 project information





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1. DHK & Liantang Contract 2 information

Dragages Hong Kong in 2017



PARIS- 15 November 2017





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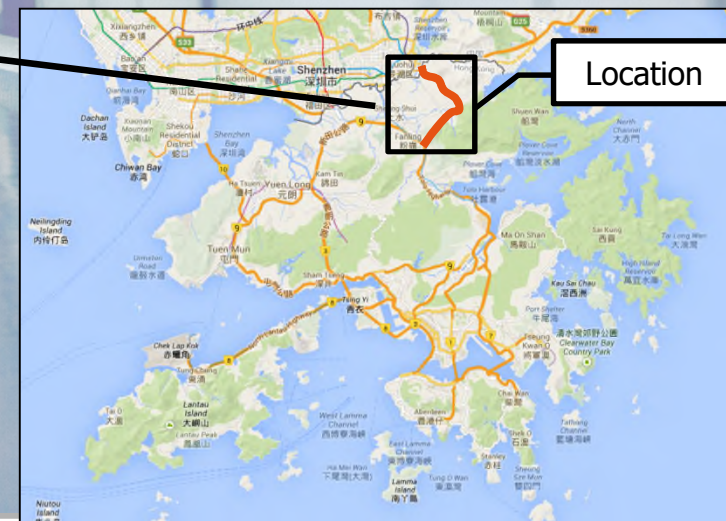
1. DHK & Liantang Contract 2 information

Project Location



Liantang / Heung Yuen Wai Boundary Control Point Project (2013-2018)

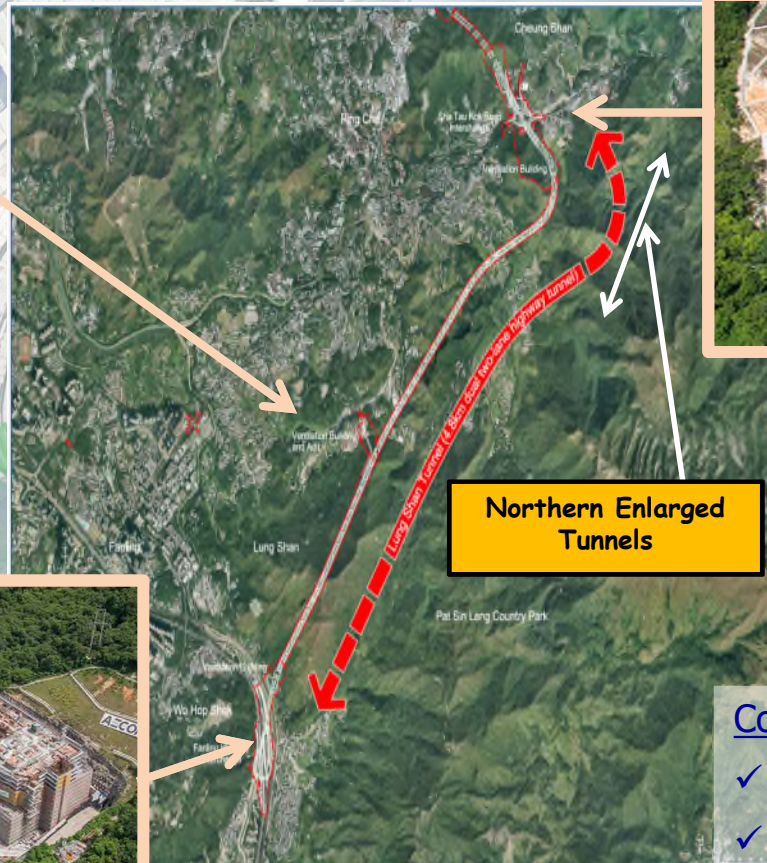
- ✓ 11km long project
- ✓ Client CEDD  Civil Engineering and Development Department & Engineer 
- ✓ Contract 2 – Lung Shan Tunnel to Dragages HK
- ✓ Contract 2 - 1.3 Billion US\$



Project Description



Mid-Ventilation Adit



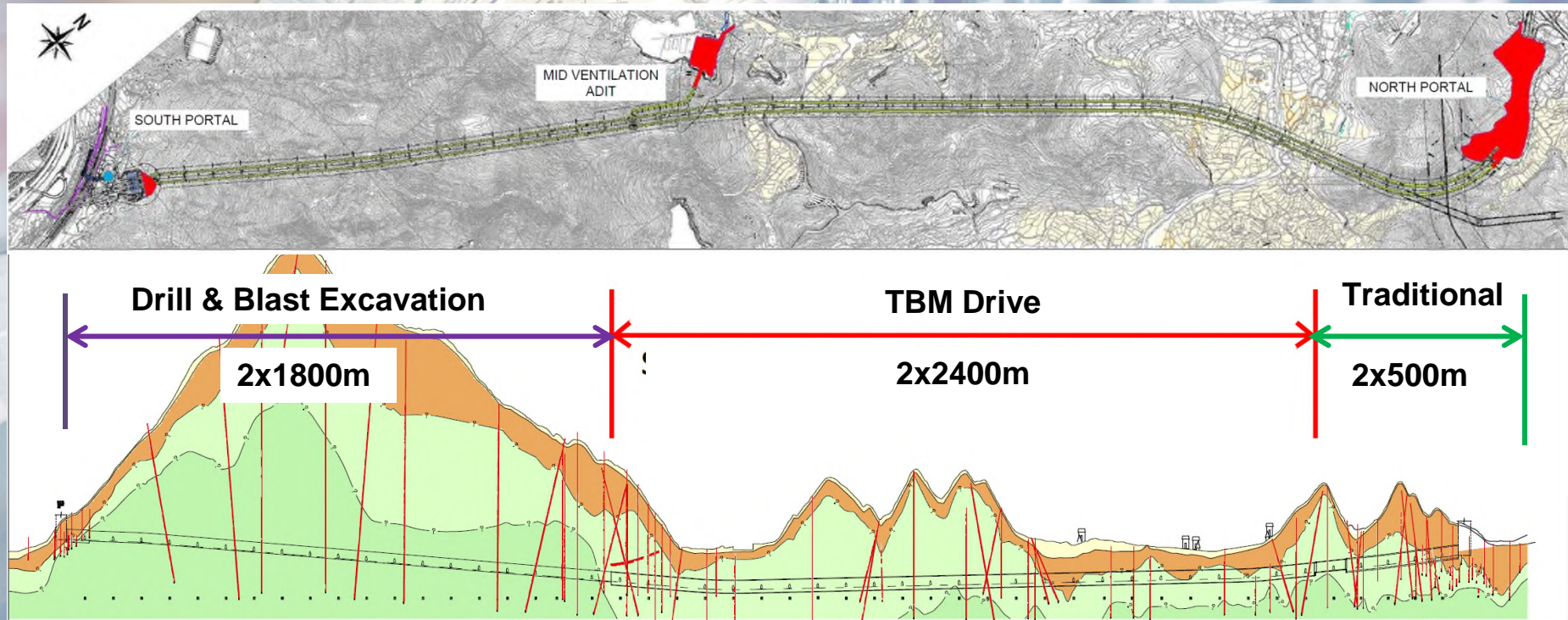
Contract 2:

- ✓ 5.4km long dual, 2 lane highway
- ✓ Twin, two lane, 4.8 km long tunnels
- ✓ 49 cross passages (every 100m)
- ✓ 4 Buildings

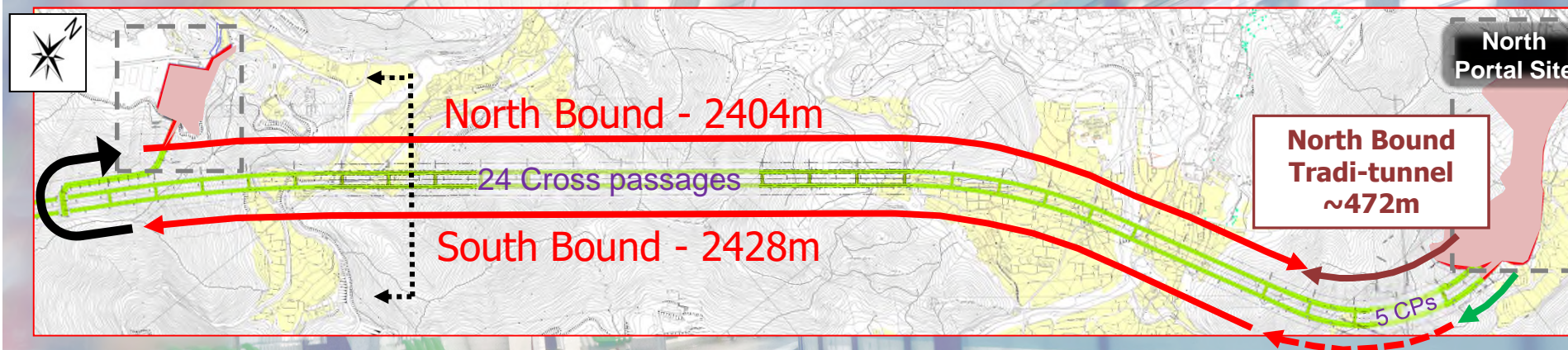
Geological Context



- ✓ Geology – Volcanic Ash Tuff rock
- ✓ Ground conditions vary from very strong rock (max $\sim 200\text{MPa}$) to completely decomposed with sections of faulted ground and low ground cover



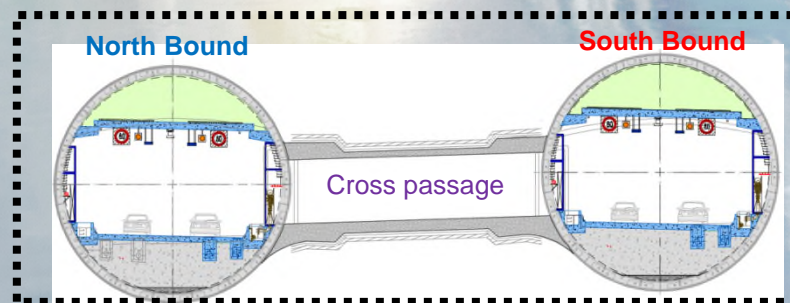
Northern Tunnels



**TBM U-Turn in
Mid – Vent
Cavern**

TBM Tunnels – 14.1m dia. EPB machine

**South Bound
Tradi-tunnel –
204m**

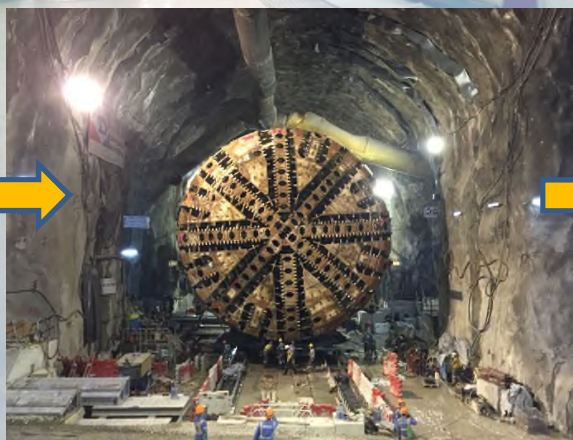
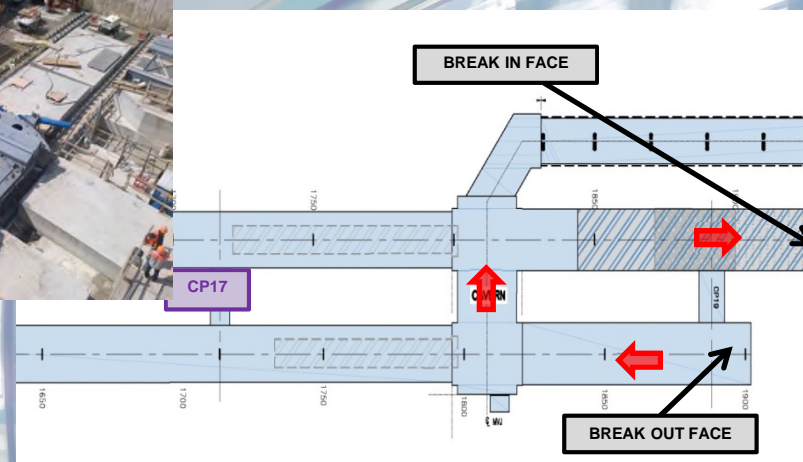




Technical challenges



- ✓ Cavern dimension (22m span, 23m Height)
- ✓ Overall schedule improvement by turning the TBM underground rather than dismantling and relaunching from the north





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2 TBM Description



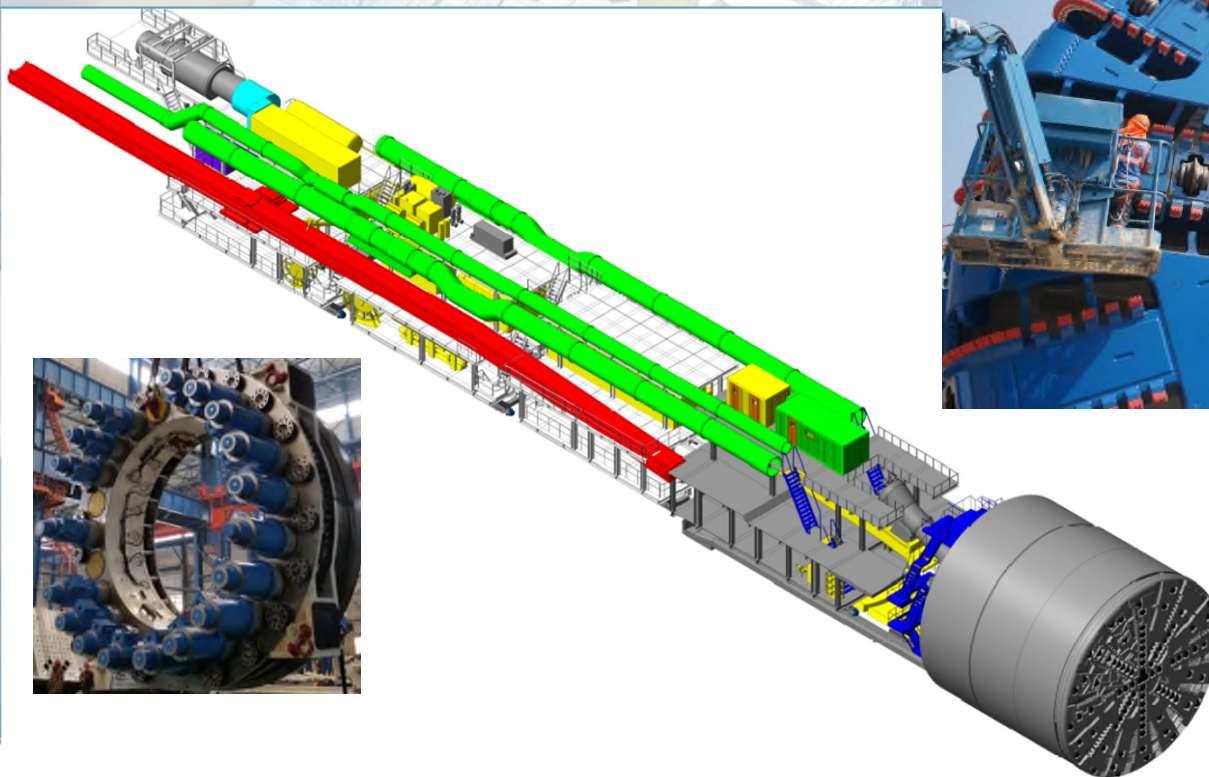


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2. TBM Description

Princess Xianglong TBM

- ✓ 14.1m dia. EPB TBM (Supplier NHI / NFM Technologies)
- ✓ Shield 12.27m long with 4 back-up gantries
- ✓ Screw 1.4m diam.
- ✓ Total installed power - 7700 KW



TBM Assembly



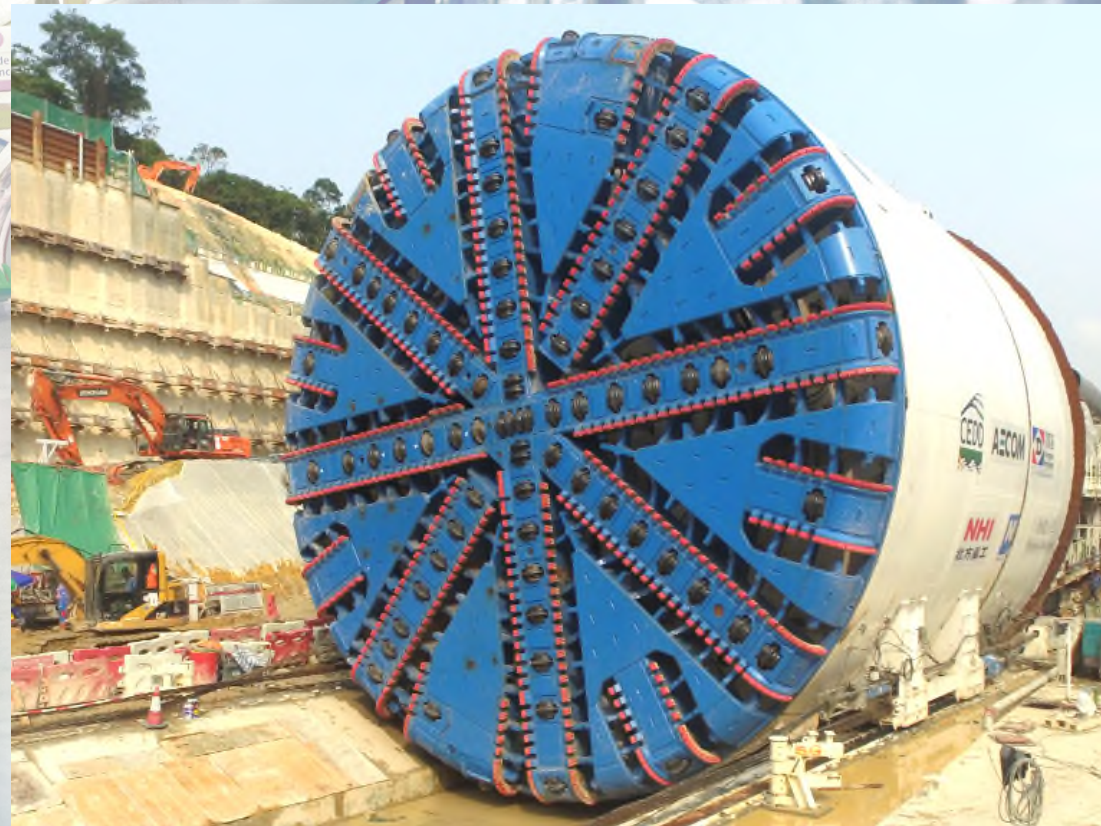
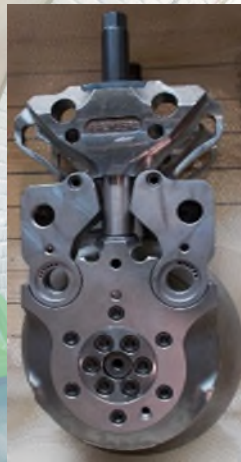
- ✓ All TBM parts on site June'15
- ✓ Commence boring 5th November'15



CUTTERHEAD DISCS



- ✓ 77 disc cutters mounted on the cutter head.





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3 Cutterhead Disc Changing System Innovation





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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

Deepening of underground works



When town density increases, networks go deeper

Increased
maintenance

Scarce resources

Programme a
cost impact

Health, Safety and Wellbeing

10m

20m

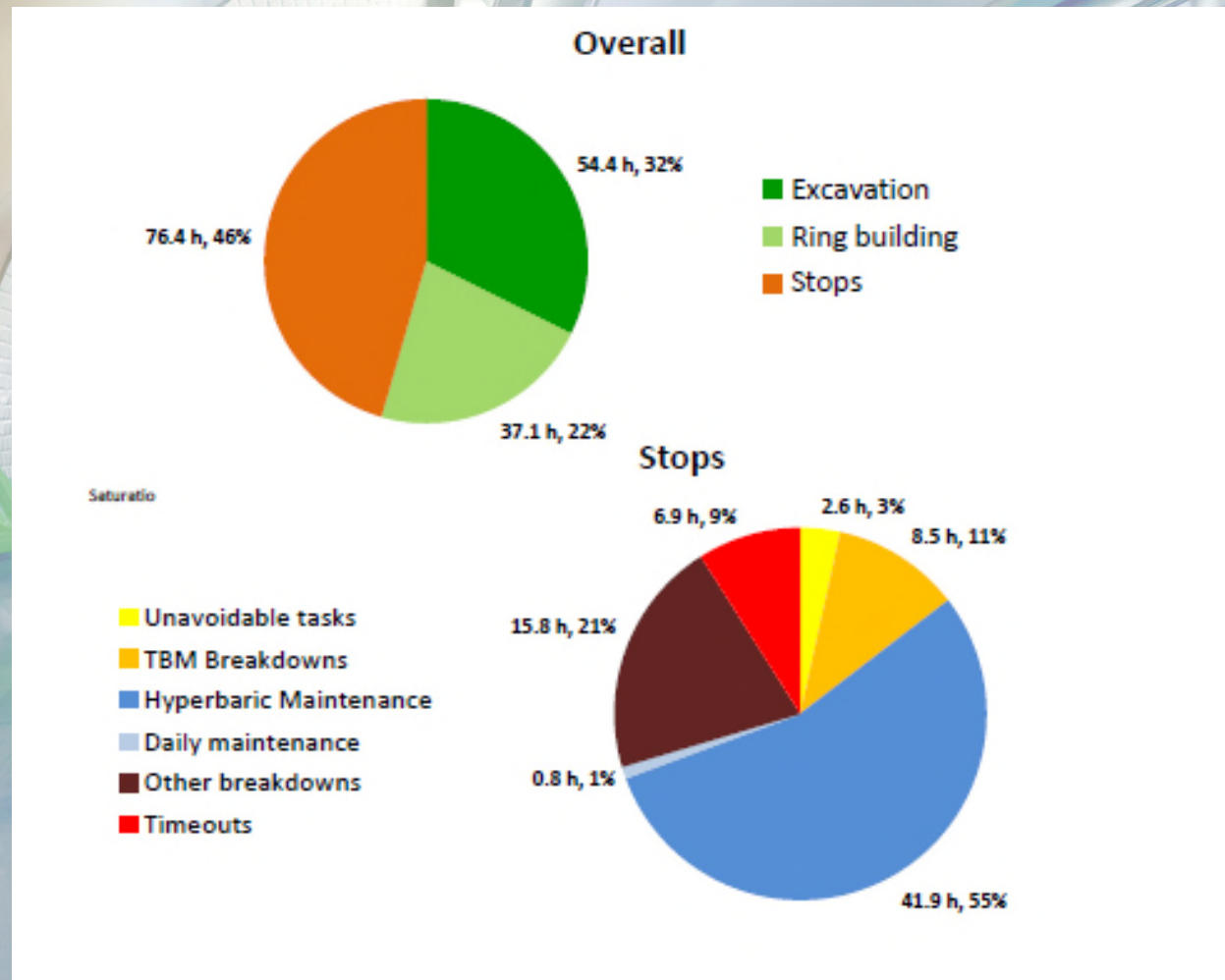
50m => 5 bars



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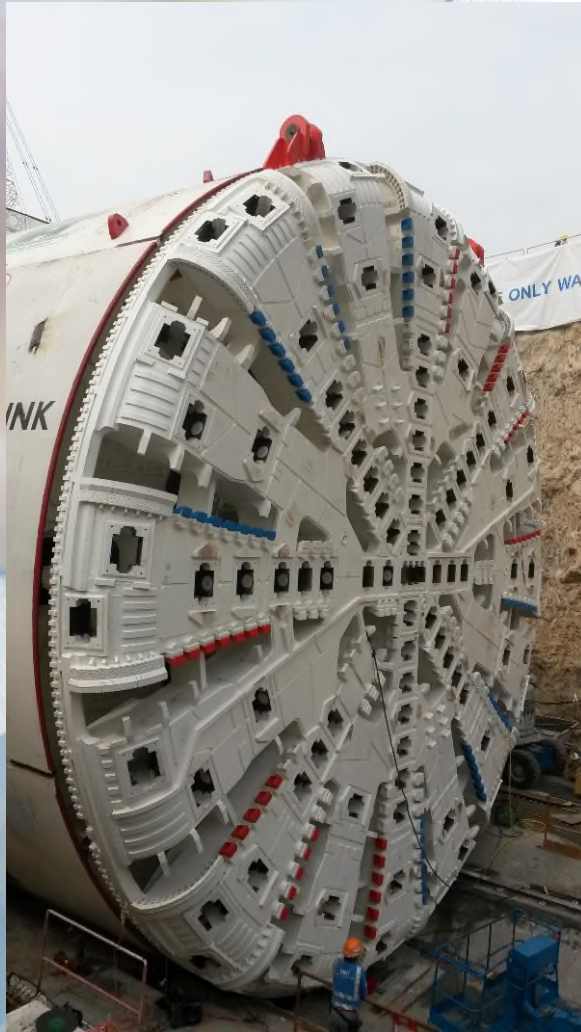
3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

TBM tasks split



3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

TBM Cutter disc replacement task



outside



Worker cleaning cutterhead in pressurized
excavation chamber



inside

TELEMACH general definition



✓ New technology for safe maintenance of tunnel boring machine cutter heads in hyperbaric conditions, which lead to develop :

- ❑ A new disc-cutter supporting system called "Muguet", patented by BOUYGUES TP.
- ❑ A Robot arm and its tools able to manipulate this new disc-cutter assembly in Hyperbaric condition without any human helps.

Liantang Telemach in TBM machine





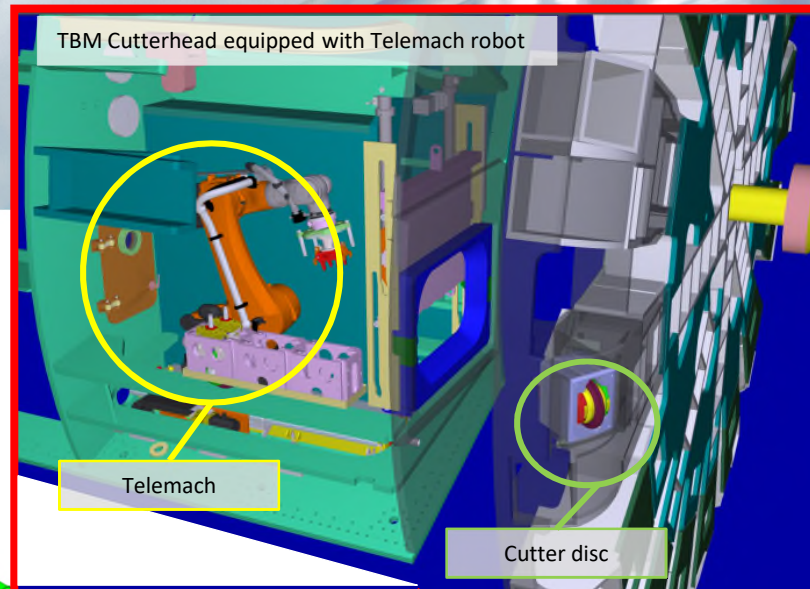
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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

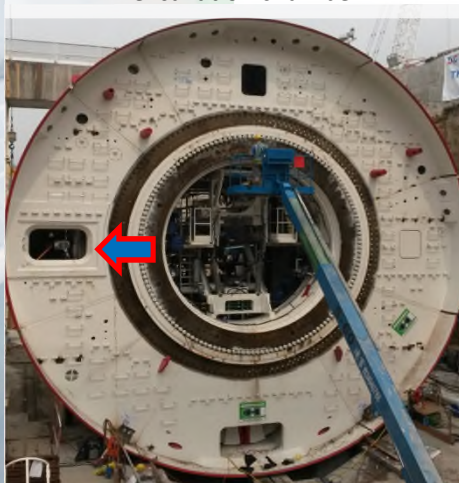
Telemach in Liantang TBM



TBM Cutterhead equipped with Telemach robot



TBM Shield without cutterhead-
excavation chamber





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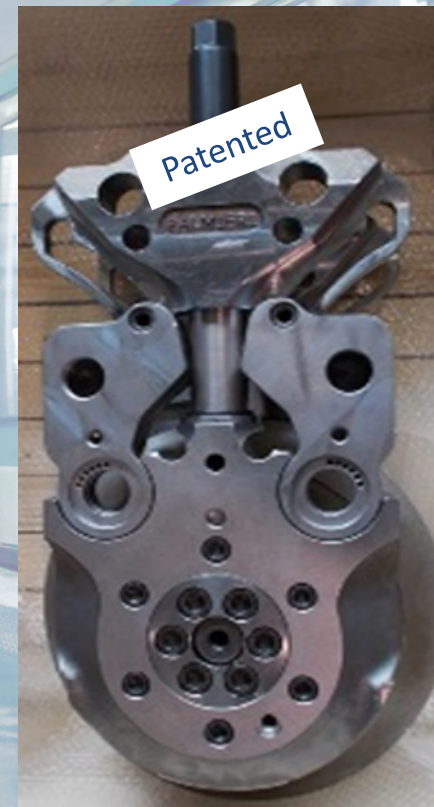
3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

TBM Cutter disc Muguet



11 separated parts
Best manual replacement time **45mn***

R&D



Only 1 part – 300kg
Only **25mn***

(* Manual exchange without logistical considerations)

TELEMACH



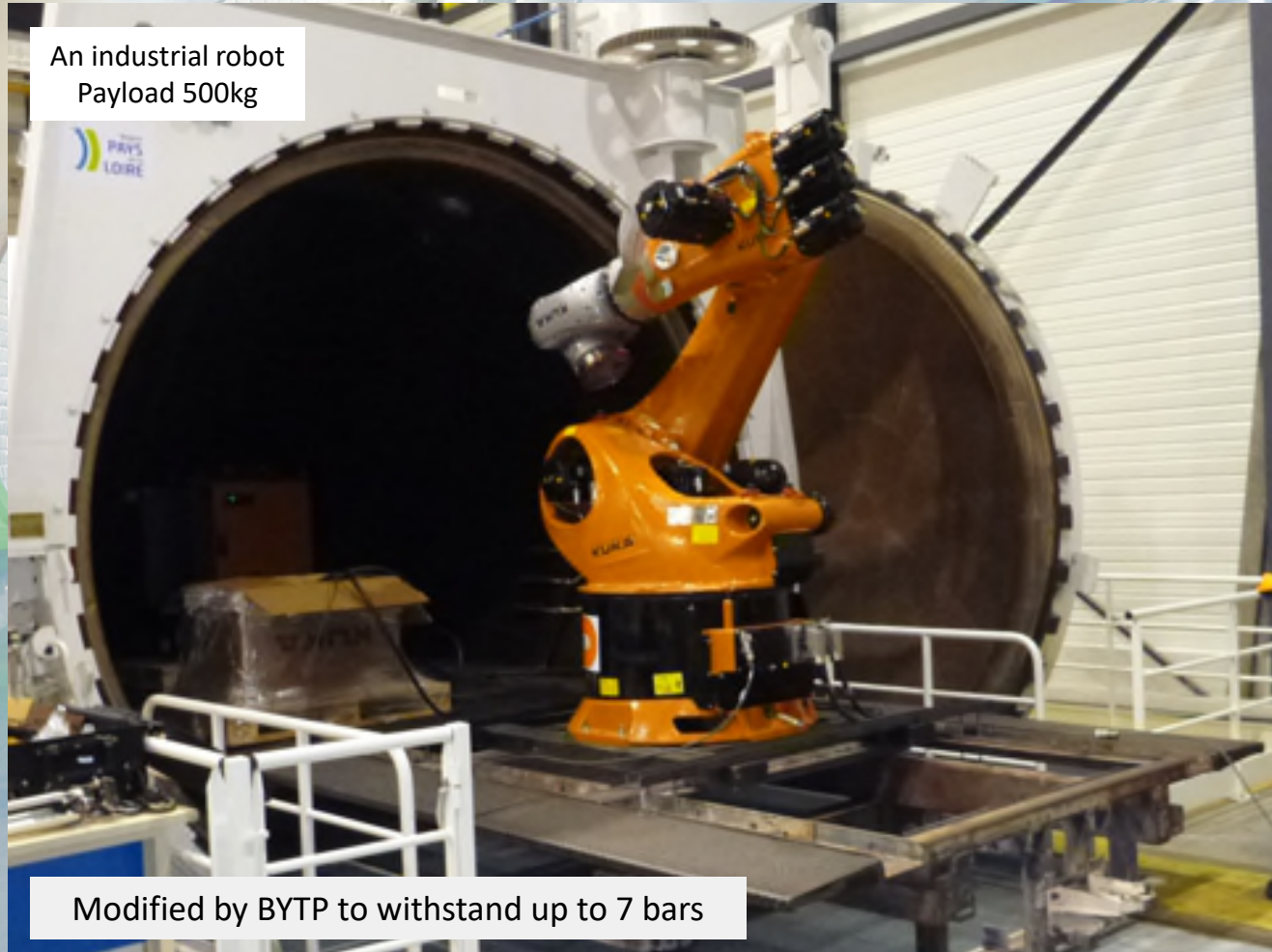
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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

Telemach



An industrial robot
Payload 500kg



Modified by BYTP to withstand up to 7 bars

TELEMACH



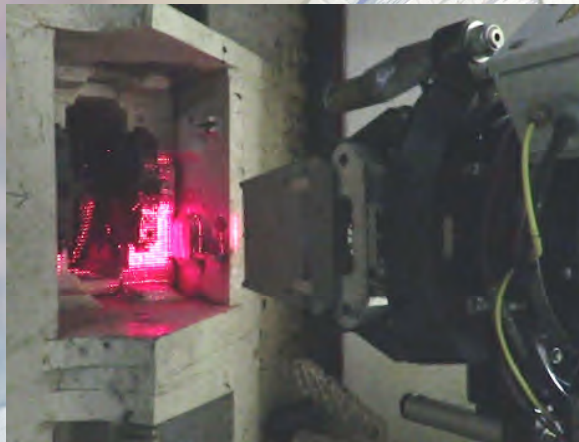
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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

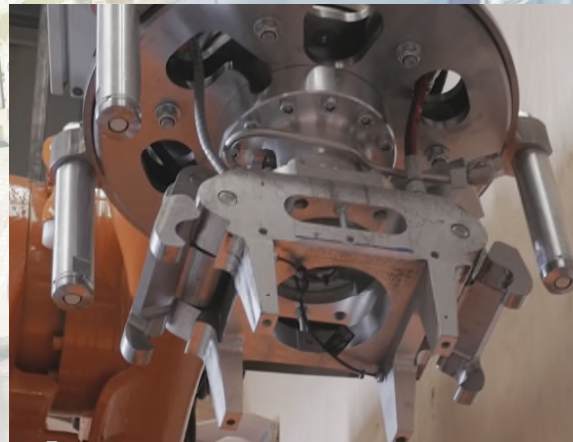
Telemach



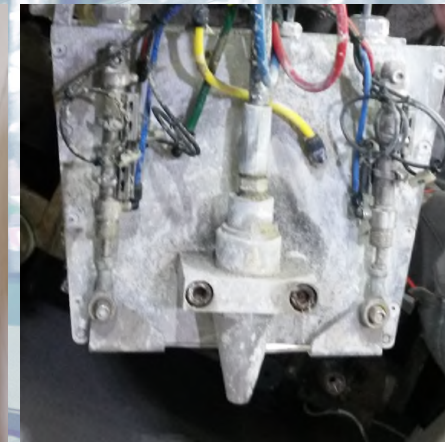
Stereoscopic
laser vision driven



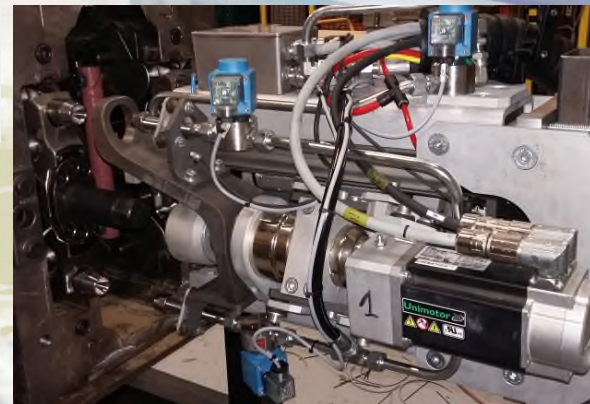
Force control
i.e. active touch sense

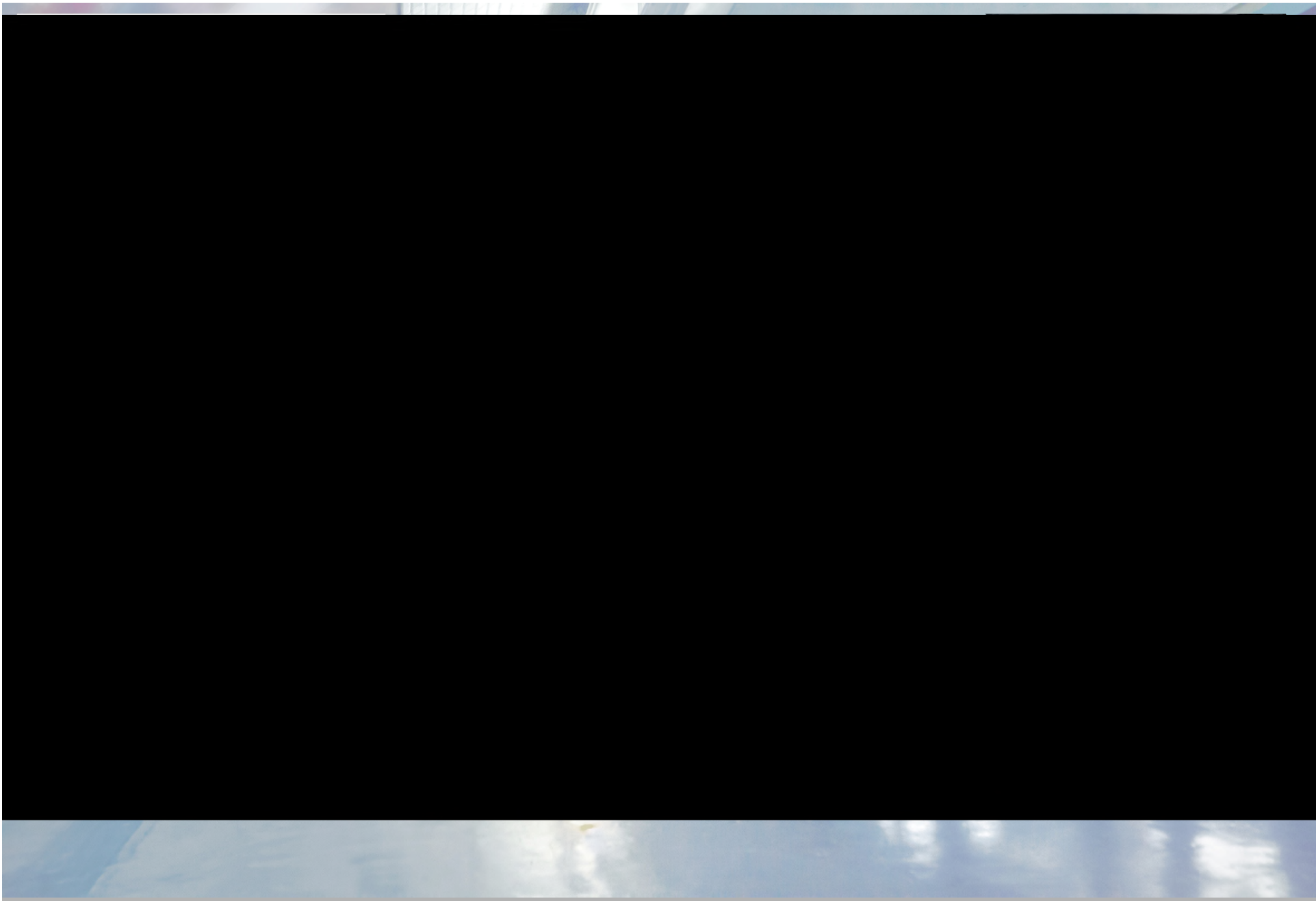


Water cleaning jet
400 bar



Torque controlled screw
driver device





TELEMACH



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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

Telemach



	Human Intervention	TELEMACH
Time taken per disc exchange	4 hours	1.5 hours
Avg no. of disc exchanges per TBM stop	8	8
No. operatives required per disc*	5	2
Total man hours required per TBM stop*	160 hours	24 hours
Typical days required per TBM stop	6 days	3 days
Typical no. cutter head replacements per tunnelling year (in challenging geology)	9	9
Total lost tunnelling time per year	54 days (1,440 man/hrs)	27 days (246 man/hrs)

* Operatives work no more than two hours on disc replacement operation due to hyperbaric conditions plus one safety officer per 8 hour shift.

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3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

Telemach



- Performance => new possibilities
- Safety for workers => exposure reduction
- Less time for maintenance => cost efficiency
- Project planning reduction => earlier use



Health and long term wellbeing



3. CUTTERHEAD DISC CHANGING SYSTEM INNOVATION

TELEMACH Recognized Safety Innovation



- ✓ Dragages Liantang Contract 2 team has been honored to be awarded by its client the « Civil Engineering and Development Department **(CEDD) Innovation Award for Site Safety 2016 –Merit Prize** » for Telemach innovation
- ✓ We received the award at the 8th **CEDD Construction Site Safety Award** on 31st May 2017. The awards commended contractors with outstanding safety performance at its construction sites in 2016.





DHK & LIANTANG CONTRACT 2 INNOVATIONS



**Cutting Disc replacement
TELEMACH**



**TBM JET "SNAKE"
Cutterhead cleaning and
inspection device**



**"ROBY 850"
Concrete anchors installation robot**



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THANKS



PARIS— 15 November 2017

