



## Referent



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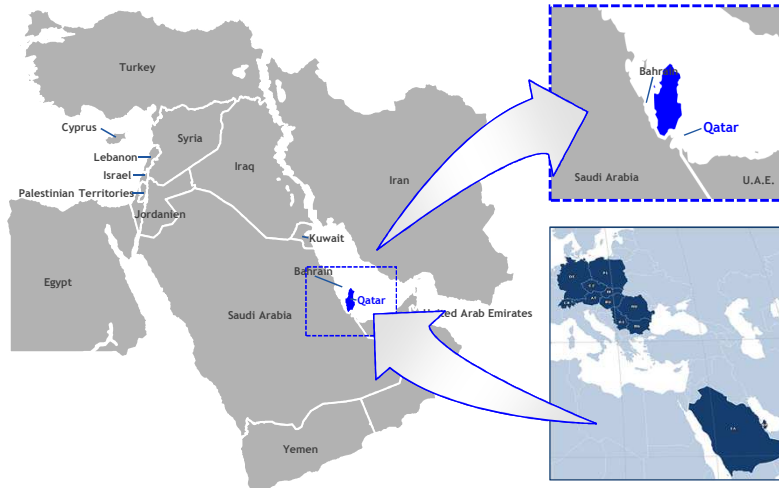
Metro Doha Greeline

**PORR**

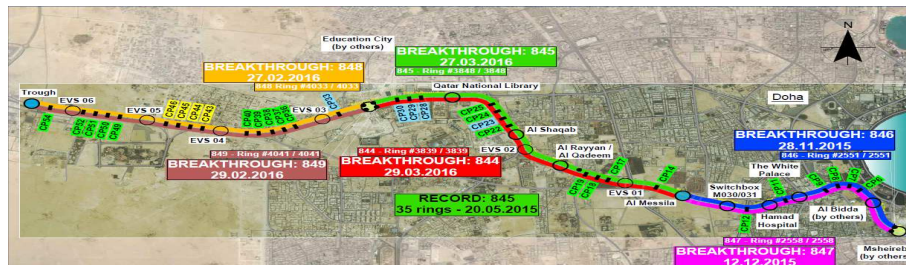
**PORR**

## Introduction

### ➤ Project presentation



## Contract data

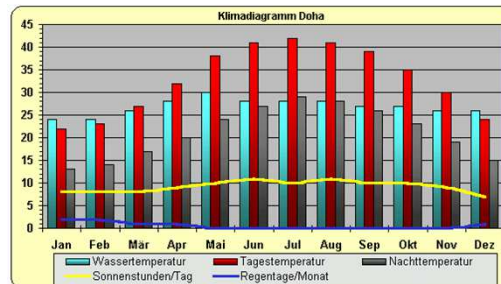


<b>SCOPE OF TUNNELLING WORK:</b>	2 x 16,7km tunnel with 6 Earth-Pressure-Balance TBM (max. tunnel length per machine: 6,51 km) 32 cross passages 2 NATM underpasses
start of contract:	Jun 2013
start TUNNEL construction:	Jun 2014 (TBM - assembly works)
TBM advance:	Sep 2014 - Mar 2016
Underpasses NATM works:	Sep 2016 - Mar 2017
Project finalization:	Mar 2019



## Climatic challenges

- The weather ranges from high humidity up to 85 % (muggy, subtropical) and very hot desert air (dry and dusty wind from northwest „Schamal“)
- Affects the production:
  - from mid-June to mid-September work cannot take place between 11 am and 3 pm



## Cultural challenges

- mixture of different cultural backgrounds, countries of origin and mentalities
- cooperation between European specialists with mostly unskilled laborers from different countries
  - Level of education of most laborers not comparable with the European standard
  - Low degree of knowledge of English and illiteracy makes communication difficult
  - High error and hazard-potentials



### RAMADAN:

- Muslim workers have shortened working times during Ramadan
- Religious restricted times for food and fluid consumption



## Occupational Health & Safety

- At peak production - approx. 1000 employees + 4000 laborers on site
- matured health and safety concepts are on one level with European projects (Zero Harm Policy)
  - Health & Safety Team included more than 200 employees
  - In-house training center for employees and laborers
  - intensive guidance and supervision by qualified staff and constant repetition of task briefing and toolbox talks, etc. to avoid accidents



Toolbox Talk

But the efforts bearing fruit:

Information published on 14 October 2014 in the UIC electronic newsletter "UIC eNews" Nr 419.

HSSE-Training centre

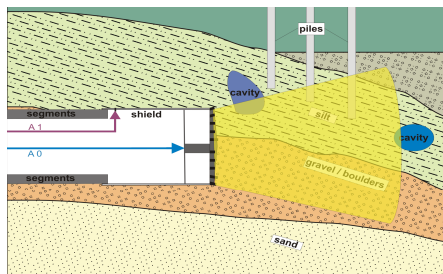
Qatar: Qatar Rail celebrates 6 million man-hours incident-free safety record at the Doha Metro Green Line works



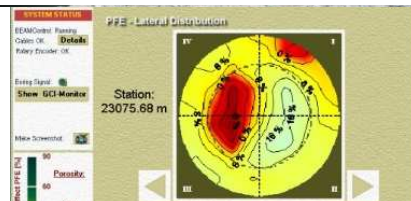
## Geological challenges

Tunnelling in a potentially karstic environment:

- Risk reduction by geotechnical exploration drilling, seismic measurements & BEAM pre-exploration system on each TBM
- Drill rigs for preliminary exploration on each machine



BEAM - Bore-Tunnelling Electrical Ahead Monitoring



BEAM system shows areas of low density / higher porosity, detects faults or similar vertical features



## TBM logistic

- No. of EPB-TBM used: 6
- total weight: app. 850 to
- excavation diameter: 7,10 m
- length of TBM: 120 m (incl. backup)
- total weight: approx. 850 t
- speed cutterhead: max. 4,5 rpm



TVM S-844/845, TBM launch, Al Shaqab, 18.10.2015



## TBM - logistic challenges



segments transport to TBM by Multi-Service-Vehicle (MSV)



conveyor belt system for 4 TBMs at Al Messila



## TBM - logistic challenges



- at the end of the project approx. 75 km of conveyor belt were installed
- about 1.3 million m<sup>3</sup> spoiled material has been transported



## TBM - logistic challenges

Pull-through of the TBMs through stations under construction



- **Power**
  - diesel consumption approx. 20.000 l per day
- **Water**
  - Cooling of approx. 5000 m<sup>3</sup> per day from water desalination plants
- **Mortar**
  - approx. 500 m<sup>3</sup> per day (for 6 TBMs) from 3 mortar mixing plants

Excavation pit Hamad Hospital



## TBM - logistic challenges



pull through of TBMs during excavation and concrete works in the station



## TBM cutter head tear & wear

- cutter head: 30% open with  
40 discs,  
102 scrapers



# TBM Breakthrough



best daily performance (1 TBM): 56 m  
best weekly performance (1 TBM): 278 m  
best monthly performance (1 TBM): 864 m  
best monthly output (all 6 TBM): 3520 m



Breakthroughs in Al Bidda & EVS 04



# NATM WORKS WORKS



Underpass at Hamad Hospital Station





## NATM WORKS - Forepoling

- Drill rig Sandvik DT920i with pipe umbrella drill system - import from Europe



- 5000m pipes Ø139mm + T45 drill steel - import from Europe



## NATM WORKS - Excavation

Local machines, only with operator:

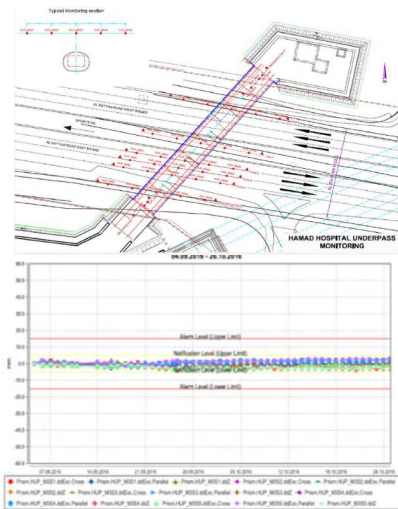
- 1 x loader (4,5m<sup>3</sup> shovel), trucks
- 2 x 20t excavators, incl hammer, mill



## NATM WORKS - Monitoring

Proposed displacement values:

- Settlements @ surface caused by tunneling
  - Warning Level: 5mm
  - Alarm Level: 15mm



## NATM WORKS - Mesh & Lattice Girder

Lattice Girder Pantex 70/22/32, 5x parts/arch - 1arch/round, transport via air / sea freight



Telehandler with man basket for mesh & Lattice Girder

2 layers mesh Q257 –  
2 squares overlapping



## NATM WORKS - Shotcrete & Anchoring

Anchor drilling with minimac



Shotcrete unit Normet 7110WPC- import from Europe  
Shotcrete C20/25, J2 early strength

Shotcrete application



## BREAKTHROUGH - Underpass Al Messila



28.03.2017: Breakthrough at UP Al Messila



## CONCRETE LINING - Invert



Invert - waterproofing, reinforcement, formwork & concrete at UP Hamad Hospital



## CONCRETE LINING - Vault



Vault waterproofing, reinforcement, formwork, concrete



## Conclusion

- The Doha Metro Green Line was a highly complex, multi-faced project
- The project required the highest level of technical and interpersonal skills and experiences
- The topic health & safety had absolute priority
- Maximum of competence and professionalism were necessary technically as well as high social competence

**THANK YOU FOR YOUR  
KIND ATTENTION!**

**DORR**