
WORLDWIDE TUNNELLING EXPERIENCE



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**Description**

The Client required the consulting of an expert in tunnel construction for the Gilgel Gibe II Hydroelectric Project (installed power equal to 250MW). The Project includes the excavation of a 25.8km long Head Race Tunnel by two Double Shield TBMs having an excavation diameter of 6.98m.

The tunnels are lined with hexagonal segments (4 per ring) 25cm thick to give an inner diameter of 6.3m.

The geology of the sector is basically composed by effusive and intrusive volcanic rocks associated with the Rift.

General information

Location: Ethiopia

Start date: 2005

End date: 2008

Client : EEPCO, Electroconsult

Technical information

Excavation: DS TBM

Lining: Precast segments

Length: 25,8 km

Excavation diameter: 6,98 m

Ground cover: 1200 m



TC Responsible: Della Valle, Nicola

Scope of work

- Analysis of documents relevant to the TBMs and tunnels design in relation with the construction methodology, expert reporting
- Analysis of documents related to tunnel lining and expert reporting
- Site visits and support to the works site
- Participation to technical and design meetings
- Expert assessment of underground works

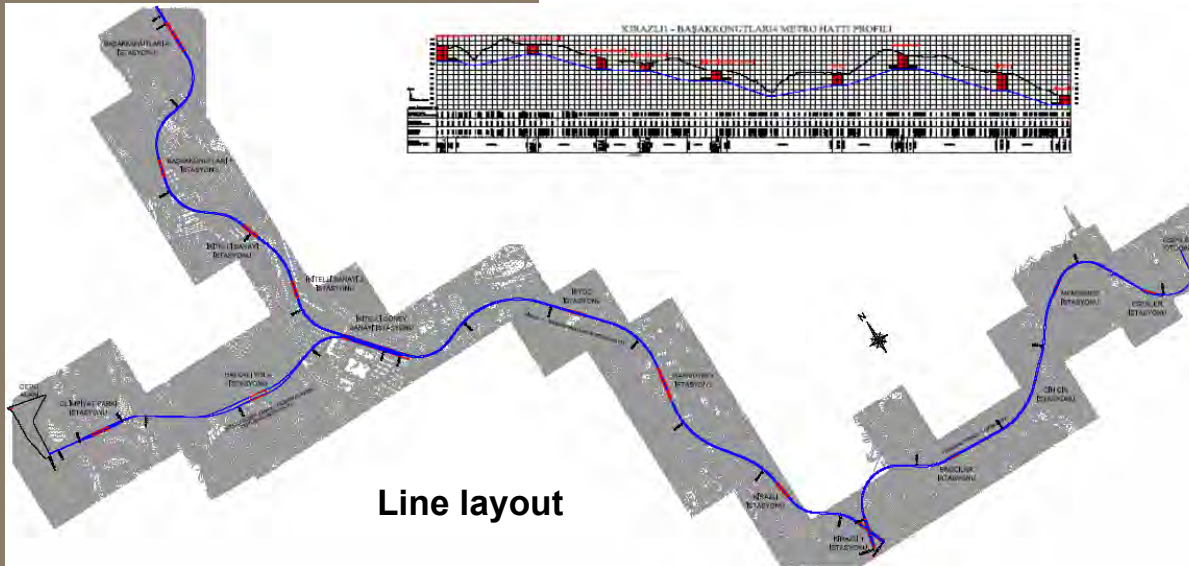
Description

Tunnelconsult has undertaken the segmental lining design of all the TBM bored tunnels of the Otogar-Bagcilar-Mahmutbey-Ikitelli-Basak Konutlari 4 metro system, counting a total of 22 Kilometres of line, designed to serve about 25.000 passenger at peak hours. Due to its length the alignment crossed various geological conditions ranging from metamorphic rocks to over consolidated sands and clay. A total of four EPB shield 6,5 m in diameter have been simultaneously boring and installing a 5+1 segmental lining 5,7 m inner diameter. Moreover we have been supporting the Contractor for monitoring, settlement and ground treatment design.

Scope of work

- Structural design of the segmental lining for the various geological conditions
- Cross passage excavation and lining design
- Thrusting frame design
- Settlement evaluation and ground treatment design
- Monitoring design and interpretation
- EPB pressure study support
- Consultancy during TBM boring

Line layout



General information

Location: Istanbul, Turkey

Start date: 05/2005

End date: 11/2007

Client: Gulermak Dogus JV

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 22 km (twin tunnel)

Excavation diameter: 6,56 m

Ground cover: 25 – 50 m



TC Repsonsible: Nicola Della Valle

Technical staff : Ranaboldo, Matteo / Di Gati, Leonardo



General information

Location: Istanbul, Turkey

Start date: 05/2005

End date: 11/2007

Client: Gulermak Dogus Joint Venture

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 22 km (twin tunnel)

Excavation diameter: 6,56 m

Ground cover: 25 – 50 m

TC Responsible: Nicola Della Valle

Technical staff : Ranaboldo, Matteo
Di Gati, Leonardo

Monitoring design for OBM Line construction:

•Underground excavation: by monitoring control sections equipped with incremental or rod extensometers, inclinometers and topographic surface control points. In particular monitoring instruments are intensified along the first 500m of tunnel driving (i.e. tunnelling learning curve). Three control sections types, equipped with more or less monitoring instruments in function of the tunnel overburden, are foreseen.

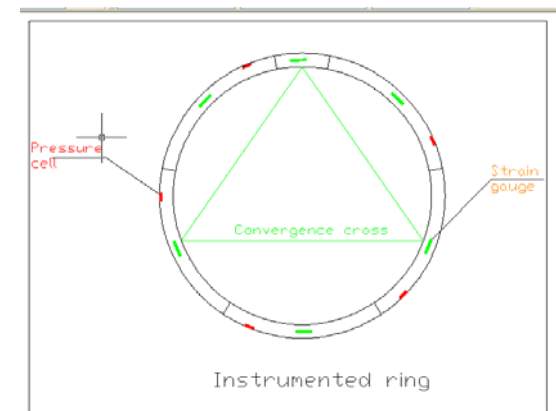
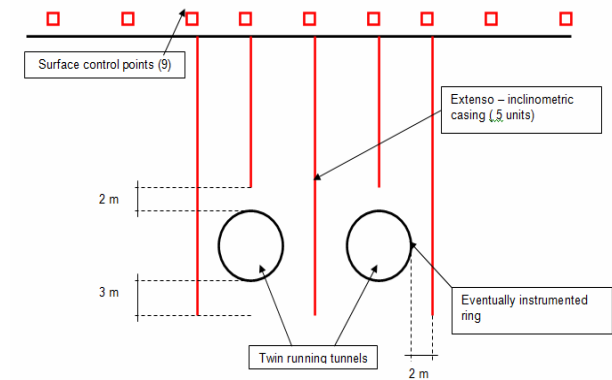
•Tunnel lining: by convergence points and monitored rings to measure strains on the segments and their internal deformations. The installed instruments are vibrating wire pressure cells and strain gauges.

•Buildings and utilities: by target prisms placed at key points of the structures and tilt meters in case of sensitive buildings or lack of visibility. Sensitive utilities are equipped with electrolytic levelling instruments and strain gauges.

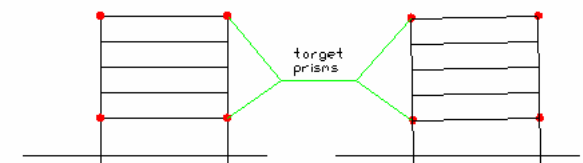
•Ground water level: by piezometers.

Scope of work

- Monitoring design
- Works follow up according to monitoring measures



Building monitoring





Description

The emergency gallery is a parallel tunnel to the main road tunnel with a length of 5345 meters and a section rate of 14 m² with 19 connections to the main tunnel, 250m long each one. Allow, through a pressurized cabin with fireproof doors, emergency exit from the tunnel.

There will be 19 galleries in connection with the tunnel, each approximately 250 meters. Each of these closures have three fire doors and an axial fan which should push air toward the pressurized tunnel to safeguard the gallery.

General information

Location: Pyrenees Mountainis, Spain

Start date: 2006

End date: 2007

Client : Paymacotas

Technical information

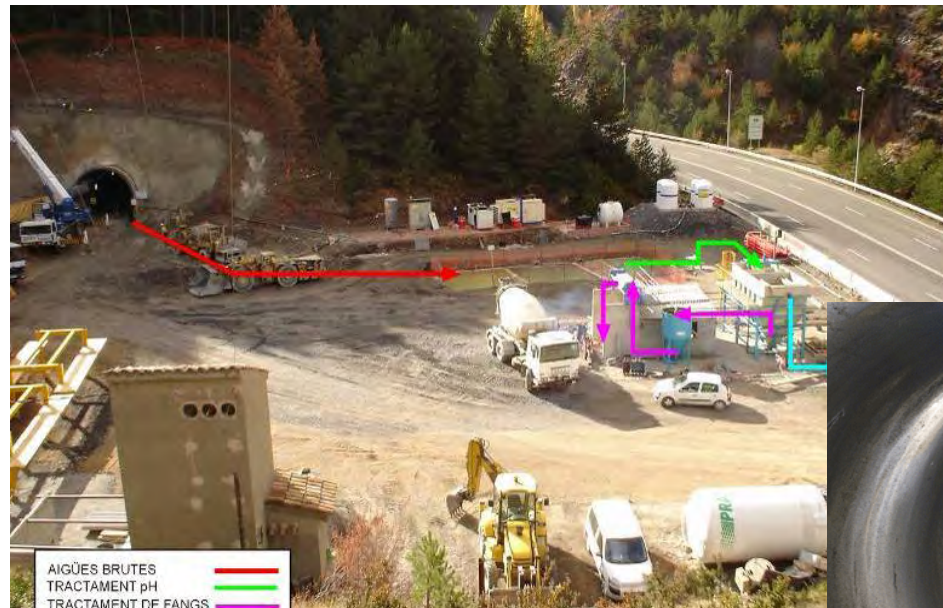
Excavation: TBM

Lining: Shotcrete & rockbolts

Length: 3,7 km

Excavation diameter: 4,0 m

Ground cover: - m



TC Responsible: Della Valle, Nicola

Technical staff:

Scope of work

- Site expert supervision
- Participation to meetings

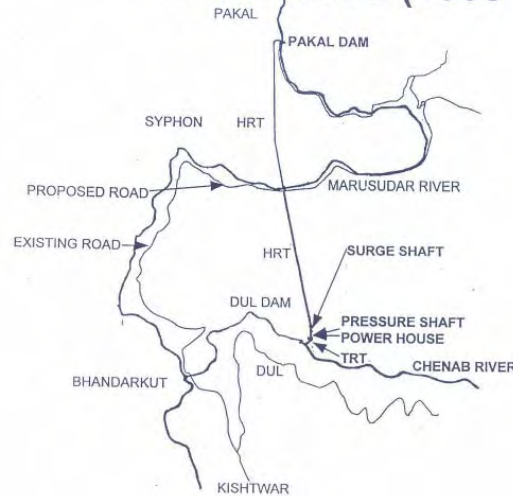


PAKAL DUL HYDROELECTRIC PROJECT IN INDIA

TENDER BASIC DESIGN



LAYOUT MAP PAKAL DUL (1000 MW)



Description

Pakal Dul (Drangdhuran) Hydroelectric Project is a reservoir based scheme proposed on river Marusudar, the main right bank tributary of river Chenab in Kishtwar Tehsil of Doda District in Jammu & Kashmir. The Project envisages construction of a concrete face rockfill dam, 167m high, across river Marusudar at village Drangdhuran and an underground Powerhouse with 4 units of 250 MW each, vertical Francis turbine, at a location 2 km u/s of Dul dam, near village Trimuli.

Between the dam and the power turbine, a head race twin tunnels are executed with 10 km long and 8.40 m excavation diameter.

General information

Location: Kashmir, India

Start date: 06/2007

End date: 10/2007

Client : Torno

Technical information

Excavation: TBM

Lining: Precast segments

Length: 10x2 km (twin tunnels)

Excavation diameter: 8,4 m

Ground cover: 2500 m



TC Responsible: Della Valle, Nicola

Technical staff:

Scope of work

- Analysis of documents relevant to the TBMs and tunnels design in relation with the construction methodology
- Assistance in defining TBM characteristics and assessing TBM performances
- Participation in technical meetings



Description

The works consist in 19km of bored tunnel in soft soil and volcanic tuffs with 6,7m excavation diameter EPB machines. 4 EPB shields are in use for the excavation of the twin tunnels. The inner tunnel diameter is 5,8m and the segments have a thickness of 30cm. The minimum possible radius is 800m and the maximum slope is 3%.

Tunnelconsult has performed a systematic support to the Constructing JV on TBM selection and manufacturing and ring design check, including feasibility studies on utilization of SFRC.

General information

Location: Rome, Italy

Start date: 02/2007

End date: 2011

Client: Roma Metro C

Technical information

Excavation: TBM

Lining: Pre-cast segments

Length: 19 km (twin tunnel)

Excavation diameter: 6,70 m

Ground cover:



TC Responsible: Della Valle, Nicola

Technical staff: Ranaboldo, Matteo / Guardia, Jaume

Scope of work

- Definition of the technical specifications for 4 TBMs
- Follow up of the TBMs manufacturing and control during the first excavation stage
- During the excavation, definition of structural improvements for the segmental lining ring

**General information**

Location: Buenos Aires
(Argentina)

Start date: 2007

End date: 2012

Client : City of Buenos Aires,
DGRBM-SPUCE

Technical information

Excavation: TBM (2 EPB shields)

Lining: Precast segments

Length: 4,6 + 9,84 km

Inner diameter: 6,90 m

Ground cover: 18-35 m

Description

Arroyo Maldonado Flood Relief Tunnels, a project under the City of Buenos Aires Government with World Bank Funds, was initiated to alleviate severe urban flooding problems in the city of Buenos Aires.

The City of Buenos Aires frequently suffers from serious flooding that damages property, the economy, and affects its population. Natural phenomena such as intensive rainfall in urban catchment areas, and high tides caused by strong winds in the Rio de Plata ("Sudestada"), are compounded by deficient drainage infrastructure.

The project includes the construction of two relief tunnels of the existing superficial box culvert (65 m²) which collects the water of the Maldonado basin. Waters diverted underground are conveyed to the shore of the River Plate, where they are delivered to the river by large diameter shafts. Tunnels work constantly submerged, when a minimal hydraulic pressure differences make the system work.



TC Responsible: Della Valle, Nicola

Scope of work

Revision of tender documents

- Site follow up on mechanized tunnelling
- Consulting to the Client of the Tunnelling Methodology
- Reporting on site advance
- Reporting on construction issue
- Revision of monitoring plan
- Reporting on special issue of City concern.



Description

The Font Santa-Trinitat tunnel, under Collserola Mountainis, started simultaneously on both portals Trinitat and Just Desvern, with two Double Shield TBM of 6,0 m of excavation diameter, leaving an internal diameter of 5.20 m. Inside it is placed on one side the pipe with 1800 mm diameter and in the other side a rail way for the electric vehicle maintenance. The tunnel has modern facilities for ventilation and security in accordance with current regulations.

Three additional emergency galleries and a surge tank were done with drill & blast and raise-boring methods respectively.

General information

Location: Barcelona, Spain

Start date: 2007

End date: 2010

Client : Paymacotas

Technical information

Excavation: DS TBM

Lining: Precast segments

Length: 12,0 km

Excavation diameter: 6,0 m

Ground cover: 325 m

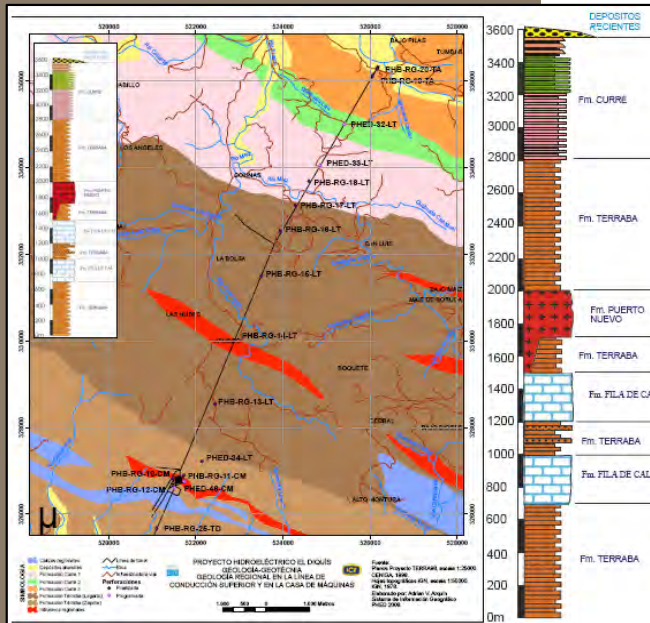


TC Responsible: Della Valle Nicola

Scope of work

- Site expert supervision
- Participation to meetings and expert advice on tunnelling issues





Description

ICE (Instituto Costarricense de Electricidad) required recommendations and technical support by tunnelling experts in order to study the feasibility of excavation by TBM for the execution of headrace tunnel of El Diquís hydro electrical project. The project, furthermore than the dam reservoir and a subterranean power house, includes a 10,4km long tunnel, 11 meters excavation diameter.

Geology comprises basically two formations: Curré formation, composed by an intercalations of lutites, sandstones and conglomerates, and Térraba facies Lagarto formation, formed by lutites, sandstones and calcareous breccias.

A single shield hard rock TBM has been considered for the tunnel excavation installing a 40 cm thick segmental lining.

General information

Location: Costa Rica

Start date: 09/2008

End date: 12/2008

Client: ICE

Technical information

Excavation: TBM

Lining: Pre-cast segments

Length: 10,4 km

Inner diameter: 9,2 m

Ground cover: up to 600 m

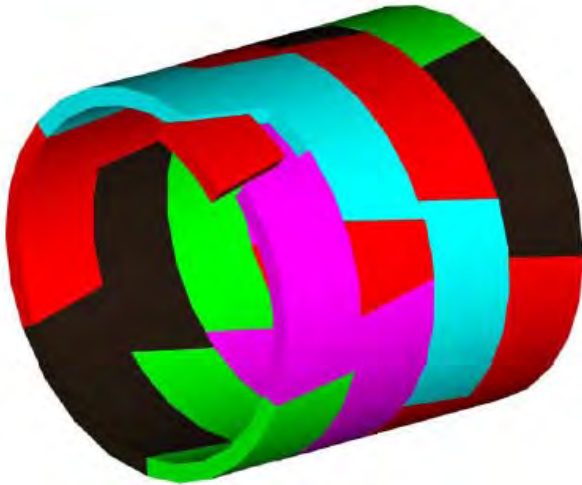


Scope of work

- Revision of geological-geomechanical conditions
- Risk analysis related to TBM excavation
- TBM technical specifications
- Time/costs estimation
- Recommendations of required additional investigations

TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi / Lemos, Mariana



General information

Location: Panamá City
(Panamá)

Start date: 2008

End date: 2008

Client: Ghella / Astaldi

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 8,0 km

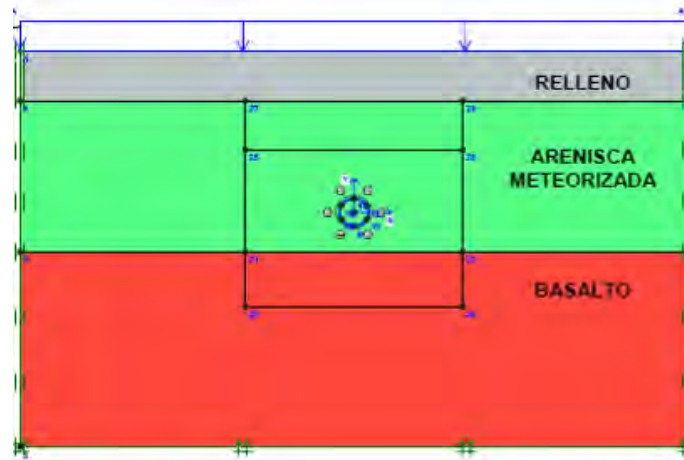
Inner diameter: 3,1 m

Ground cover: up to 30 m

Description

The Project consist in deep sewer system which will collect water along the alignment to a to a pump station for further treatment.

The geology comprises basalt, breccias and geological units of a sedimentary sequence. It has been appraised that 75% of the tunnel will be excavated in good geo-mechanical quality rock and the remaining 25% in weathered rock and soil. It is expected that the tunnel alignment will cross three faults. The main TBM characteristics that have been considered are: excavation diameter, cutter-head, thrust force, par and power.



Scope of work

- Preparation of the technical report for the tender submission
- Definition of the TBM features and specifications
- Geometrical and structural lining pre-design.
- Preliminary settlement analysis
- Definition of the basic monitoring system and the general work planning

TC Responsible: Della Valle, Nicola

Technical staff: Ranaboldo, Matteo / Guardia, Jaume



Description

The fourth lot of Barcelona Metro Line 9 consists in two branches that merge before Bon Pastor station and in one branch from Bon Pastor to Sagrera. Sub-lot IVa is 4,9km long, starts in Can Zam station and includes 6 stations; sub-lot IVb is 3,8km long, starts in Gorg station and includes 3 stations. Between Bon Pastor station and Sagrera, another underground station is foreseen. The alignment runs on the eastern side of Besós River and it under cross with less than one diameter cover. The tunnel goes through Palaeozoic metamorphic rocks in contact with Miocenic conglomerates and most recent deltaic alluviums. Tunnels are lined with 35cm(IVa) and 40cm (IVb) thick, 10,9m i.d. precast concrete segments. The minimum track radius is 270 m and the maximum slope is 4%.

General information

Location: Barcelona, Spain

Start date: 2003

End date: 2010

Client: GISA

Technical information

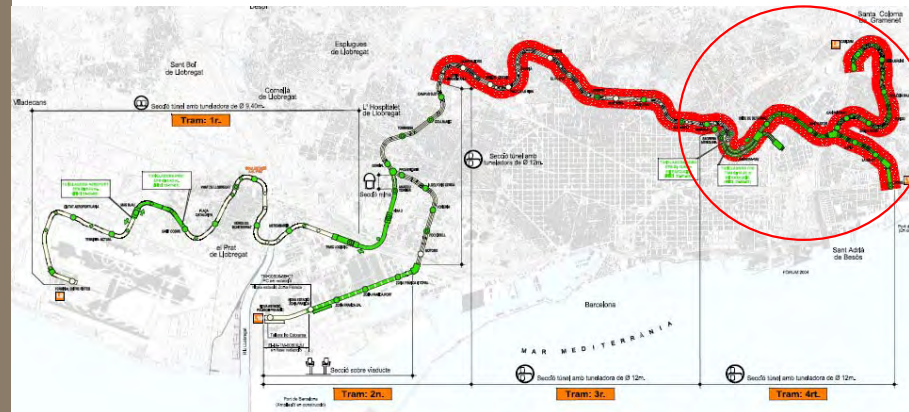
Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 8,7km

Excavation diameter: 11,95 m

Ground cover: 8 – 65 m



TC Responsible: Della Valle, Nicola

Technical staff: Plasencia, Victoria / Rabella, Alex

TC scope of work

- Works controller and construction follow up
- Design review
- Monitoring design check and follow up
- Decision support to the Client & Engineer



Description

Lot 1 of Sofia Metro Line 2 Extension Project runs from *Road Junction Nadezhda* station to *Patriarch Evtimiy blvd.* Along the alignment 4 stations are excavated, one of which will link Line 2 with Line 1. Geology consists in several layers of fine gravel, clayey sand, silt and sandy clay with variable thickness. The right control of the TBM technical specifications is essential, due to the high sensitivity of the settlements, especially when the tunnel will underpass the historical building “*Sveta Nedelya Cathedral*”. The 8,43m i.d. single bored tunnel will carry twin tracks with cur & cover stations. Minimum curvature radius is 250m and the maximum slope is 3%.

General information

Location: Sofia, Bulgaria

Start date: 2008

End date: 2012

Client : Dogus Group

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 3,2 km

Excavation diameter: 9,45 m

Ground cover: 2,5 – 28,0 m



TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi

Scope of work

- Precast segmental lining geometrical design
- Definition of EPB shield technical specifications
- Technical assistance during the contractual process between the Client and the TBM manufacturer. Commissioning supervision
- Settlements analysis and estimation of potential damages for buildings along the alignment
- EPB pressure definition along the alignment



Description

The third lot of Barcelona Metro Line 9, from Sagrera Meridiana station to Zona Universitària station, includes 13 stations, 6 of which will link Line 9 to other metro and/or railway lines. The alignment runs deep below the upper part of Barcelona Slope through a Palaeozoic series intruded by a granitic batholith.

Two 12 meters shields are performing in this stretch installing a 10,9 m inner diameter segmental lining. Segments are reinforced with a mix of conventional reinforcement (rebars) and steel fibres that give outstanding performance due to strong thoughtless and durability.

Face stability control is a must in fractured and faulty conditions, as well as face losses and settlement minimization.

General information

Location: Barcelona, Spain

Start date: 2008

End date: 2012

Client: GISA

Technical information

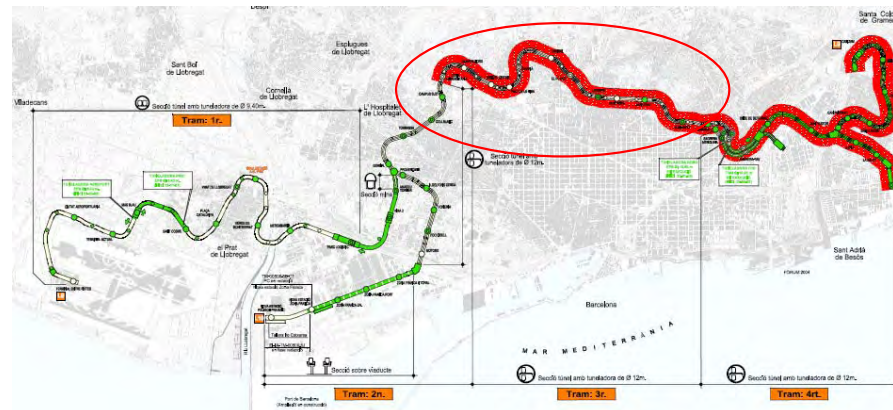
Excavation: TBM (EPB/Hard rock shields)

Lining: Precast segments

Length: 9,2 km

Excavation diameter: 11,95 m

Ground cover: 8 – 70m



TC Responsible: Della Valle, Nicola

Technical staff: Plasencia, Victoria / Rabella, Alex

TC scope of work

- Works controller and construction follow up
- Design review
- Monitoring design check and follow up
- Decision support to the Client & Engineer



General information

Location: Barcelona, Spain

Start date: 2008

End date: 2012

Client: GISA

Technical information

Excavation: TBM (EPB/Hard rock shields)

Lining: Precast segments

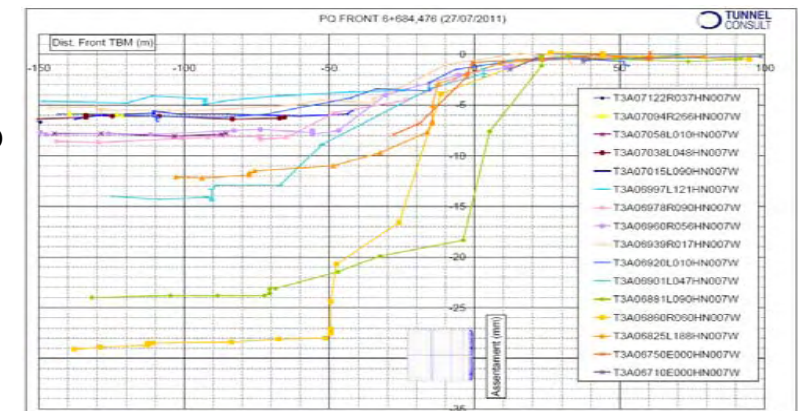
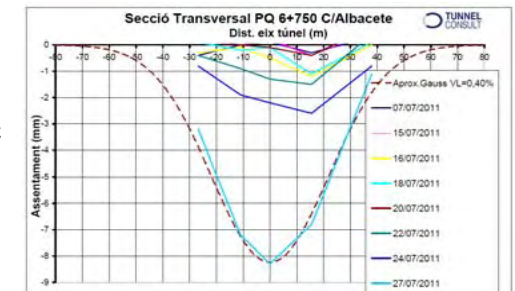
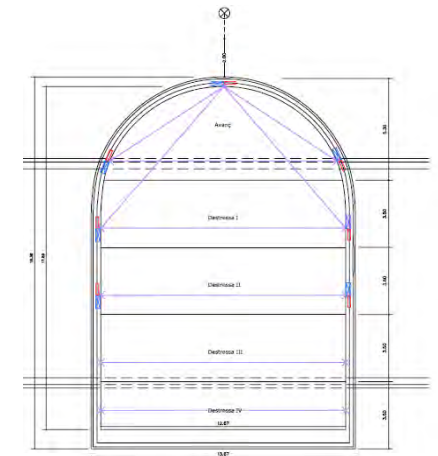
Length: 9,2 km

Excavation diameter: 11,95 m

Ground cover: 8 – 70m

Monitoring used in L9 to control:

- Underground excavation: by monitoring arrays made up by inclinometers, rod extensometers, and ground settlement monitoring points distributed in longitudinal and transversal direction along the tunnel axis, according to tunnel influence area, geological profile and urban distribution.
- Passage connection or shaft station excavation: by convergence points and rod extensometers. Covergence points are used to know horizontal and vertical movements between walls and crown; and using rod extensometer it is possible to control surface settlements.
- Tunnels: by convergence points and monitoring rings to mesured strains and movements over the segments rings.
- Buildings: by optical survey targets based in a topographic control to monitoring settlements and angular distorsion in both axes. Constant monitoring at real time.
- Ground water level: by piezometers.



TC scope of work

- Monitoring design approval and follow up
- Works controller and construction follow up, according to monitoring measures

TC Responsible: Della Valle, Nicola

Technical staff: Plasencia, Victoria



Description

Kadiköy Kartal Metro extension included a 5,3km long stretch from Kartal to Pendik with twin bored tunnels of 5,7m i.d. Tunnels have been excavated through weak to medium-strong rocks, with TBM shields capable of Earth Pressure Balance and also suitable to bore in open mode, as equipped with cutter disks on the cutting wheel. Geology basically consists in laminated limestones (Dolayoba formation) and carbonated shale intercalated with massive limestones (Kartal formation). The structural lining verification has been carried out following Eurocode 2 and relevant international standards. Particular attention has been devoted to the seismic design since an Magnitude 8,5 earthquake has been taken for the design basis. Tunnels have been lined by 1,5m long and 30cm thick precast concrete segments.

General information

Location: Istanbul, Turkey

Start date: 2008

End date: 2010

Client: Avrasya Metro Grubu

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 12,75km (twin tunnel)

Excavation diameter: 6,56m

Over burden: 15 – 30m



TC Responsible: Della Valle, Nicola

Technical staff : Ranaboldo, Matteo / Mavare, Luis

Scope of work

- TBM selection and purchase assistance to the Contractor
- Geometrical and structural lining design, considering fibre reinforcement
- Structural verification of the segmental rings located at the cross passage openings
- Design of the starting push frame
- Follow up and technical assistance during the excavation work, redacting reports on specific arguments

**General information**

Location: Ethiopia

Start date: 2007

End date: 2009

Client: EEPKO / Electroconsult

Technical information

Excavation: DS TBM

Lining: Precast segments

Length: (12 + 8) km

Excavation diameter: 8,2 m

Ground cover: >500 m

Description

The Client required the consulting of an expert in TBM tunnel construction for the Beles Hydroelectric Project (400MW installed power) on the Tana Lake, the starting point of Blue Nile. The Project included the excavation of a 12 km long Head Race Tunnel and a 8 km long Tali Race Tunnel by two Double Shield TBMs having an excavation diameter of 8,2m.

The tunnels are lined with trapezoidal segments (7 per ring) 30cm thick to give an inner diameter of 7,20 m.

The geology of the sector is basically composed by basaltic rocks and lacustrine deposits.

**TC Responsible:** Della Valle, Nicola**Technical staff:** Matteo Ranaboldo**Scope of work**

- Analysis of documents relevant to the TBMs and tunnels design in relation with the construction methodology, expert reporting
- Analysis of documents related to tunnel lining and expert reporting
- Site visits and support to the works site
- Participation to technical and design meetings
- Expert assessment of underground works

**Description**

Aslancık Dam and Hydroelectric Power Plant with a planned capacity of 120 MW and annual expected electricity generation of 418 million kWh will be located on Harsit River on province of Doğankent and Tirebolu in Giresun.

Aslancık HEPP is one of the six hydro plant planned to be constructed on Harsit River. Four of these projects have been completed and are currently operating. An alternative design considering the excavation of the 12,6 km long headrace tunnel has been studied.

**General information**

Location: Turkey

Start date: 2008

End date: 2009

Client : DOĞUŞ GRUBU

Technical information

Excavation: TBM

Lining: Precast segments

Length: 12,6 km

Internal diameter: 5,8 m

Ground cover: >500 m

Scope of work

- TBM alternative feasibility study.
- Technical specifications and main features of the TBM
- Segmental lining pre-design

TC Responsible: Della Valle, Nicola

Technical staff: Matteo Ranaboldo



Description

The hydro-electrical project “Cachí” extension consists in a 5980m long tunnel which runs parallel to operative headrace. Its construction will allow a substantial increment of the energy produced allowing for the installation of a fourth Francis turbine. The excavation will be predominantly through Doán formation, composed by volcanic rocks, being predominant breccia, lava flow and tuffs. Special attention has been devoted to study the affection of the second tunnel on the first one, since the plant must remain in operation during the construction of the second tunnel.

General information

Location: Costa Rica

Start date: 04/2009

End date: 09/2009

Client: ICE

Technical information

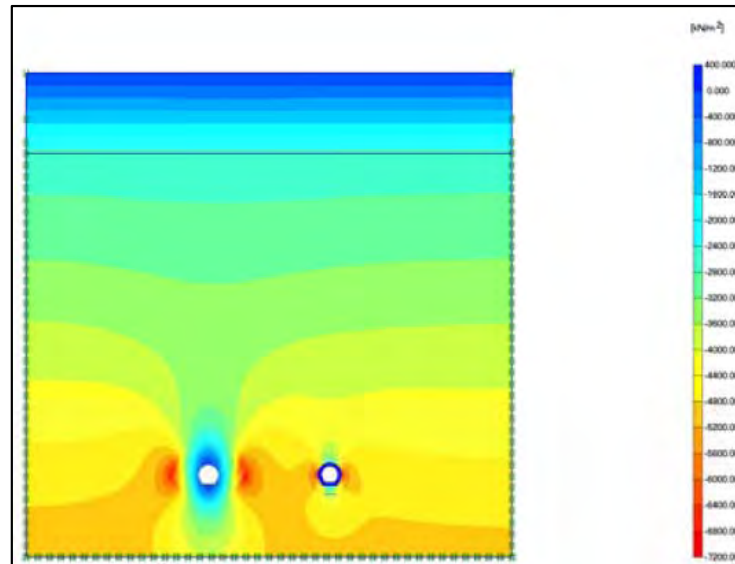
Excavation: D&B/Roadheader

Lining: Conventional

Length: 5,98 km

Diameter : 3,9 m (final)

Over burden: 30 - 190 m



TC Responsible: Della Valle, Nicola

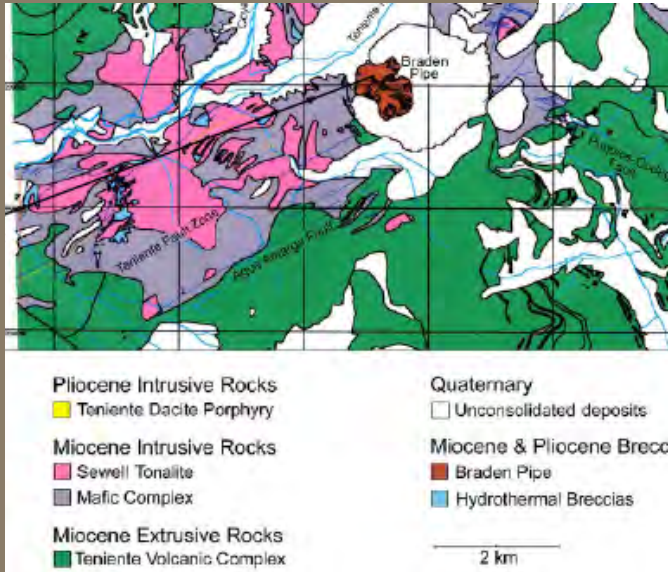
Technical staff: Savin, Eloi / Lemos, Mariana

Scope of work

- Revision of geological-geomechanical conditions
- Assessment of structural condition of the tunnel in operation since 1968
- Risk analysis and project feasibility study
- Estimation of the effects of the tunnel excavation on the existent tunnel lining which will remain in operation during the works.
- Estimation of the most suitable tunnelling technology (D&B/Roadheader/TBM) taking into account technical, economical and time related aspects
- Recommendations on investigations

MINE EXPLOTATION EL TENIENTE CHILE

TENDER ASSISTANCE



Description

El Teniente New Mine Level Project consists in two 8,9km long tunnels, one for personnel access and one for the installation of an extraction conveyor belt. For safety reasons, 24 cross passages between the tunnels and 5 refuge bays in each tunnel are foreseen.

The regional geology of the zone is characterized by Miocenic volcanic rocks intruded by mafic to felsic complexes. The alignment tunnel is sub-parallel to El Teniente fault zone which consists in a very fractured rock mass zone. In order to cross the Breccia formation, rock mass treatments are foreseen.

The minimum required gauge is of 4,15m as inner diameter (43,25m² free section) and it is the same for both tunnels.

General information

Location: Chile

Start date: 12/2009

End date: 03/2010

Client: VINCI Construction

Technical information

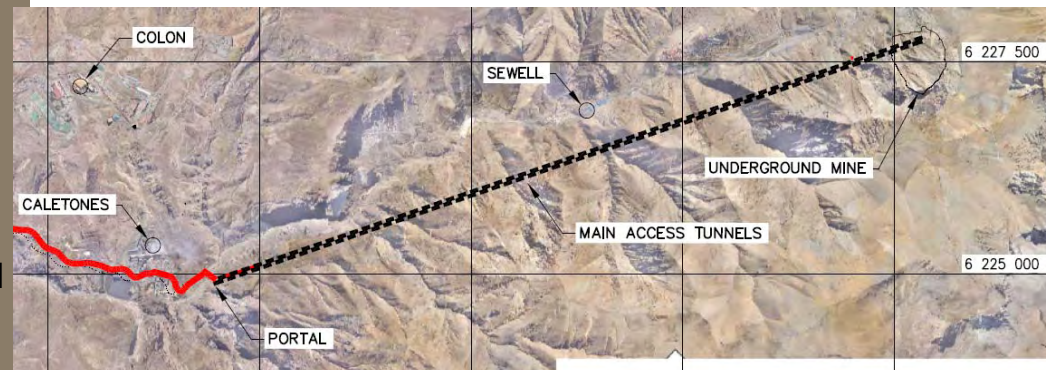
Excavation: Drill & Blast vs TBM

Lining: segmental lining rings or traditional support

Length: 10,0 km (twin tunnel)

Diameter: 7,20 m (excavation)

Overburden: up to 1.500 m



TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi

Scope of work

- Revision of the geological information
- Risks analysis and definition of mitigation actions
- Comparison between Drill & Blast excavation and TBM tunnelling
- Evaluation on the best construction alternative



Description

The designed high speed railway stretch is 4,7Km long and includes the construction of 1,0Km of surface infrastructures and 3,7Km of tunnels. Of these 3,7Km, 2,9km are bored tunnel. The scope of the tunnelling work is the underpass of Montcada town and of the Ripoll stream.

The tunnel alignment is driven below the alluvial plain of the Besós River. This alluvial plain lays on Paleozoic bedrock formed by slates and quarzitic slates intruded by a granitic batholith. The bedrock slates present a strong foliation with different weathering grades ranging from III to V .

The inner tunnel diameter is 10,40m and the 2,0m long segments have a thickness of 45cm. The minimum possible radius is 800m and the maximum slope is 3%.

General information

Location: Montcada, Barcelona

Start date: 2009

End date: 2010

Client: UTS

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 2,9 km

Excavation diameter: 11,66 m

Ground cover: 15 – 40 m

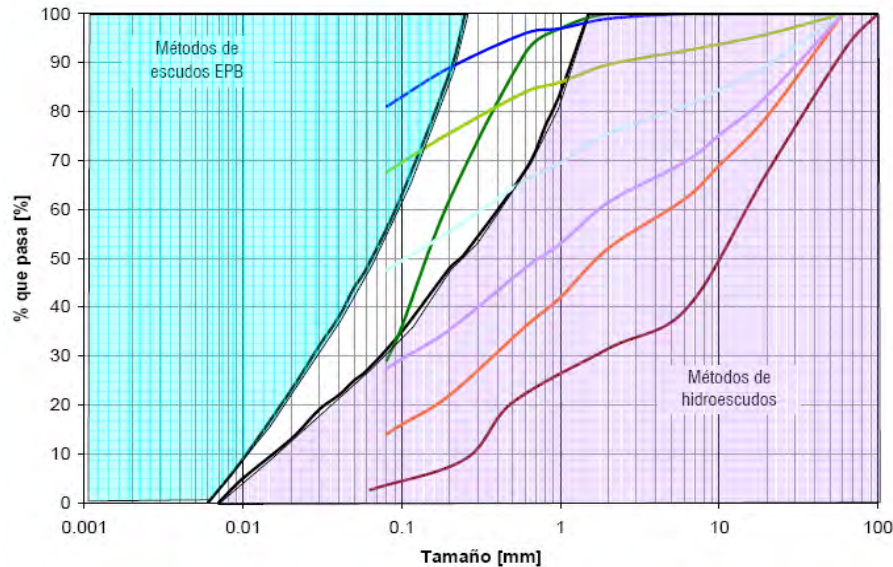


TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Savin, Eloi

Scope of work

- General appraisal report on the construction design
- Technical assistance and follow up of the excavation by supporting the site management
- Regular on site visits in order to appreciate the advance of the excavation
- Reporting on advance, TBM excavation parameters and dedicated issues



Description

The fourth Sevilla ring road project foresees the excavation of 4 tubes, three car lanes each, to cross Guadalquivir River. The clearance between each tunnel will be 100m to minimize interference during excavation and operation.

Project geology comprises Miocenic marls covered by cohesion less alluvial deposits (gravel with sandy and clayey lenses) and lacustrine formations characterized by clayey silt and fine to very fine sand.

Tunnels will have a 12,6m inner diameter given by a by 0,5m thick precast concrete segments lining.

General information

Location: Sevilla - Spain

Start date: 11/2009

End date: -

Client: UTE Autovía

Technical information

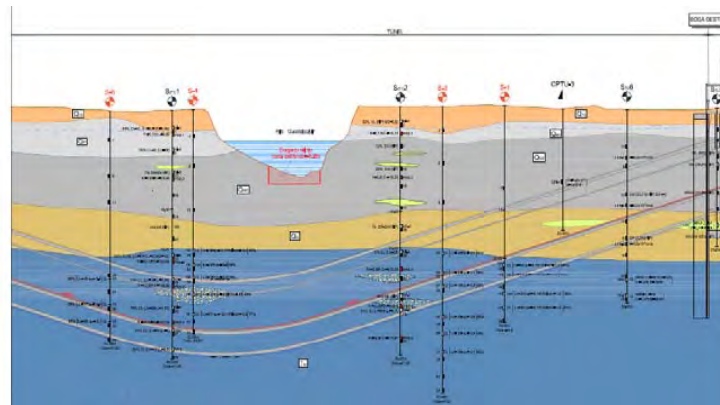
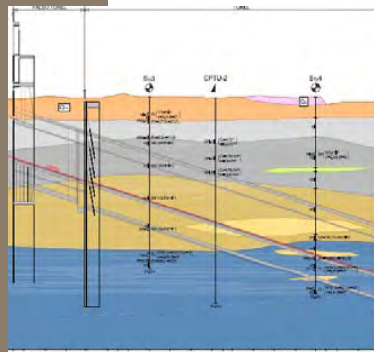
Excavation: TBM

Lining: Pre-cast segments

Length: 2,1 km (four tunnels)

Excavation diameter: 14,1 m

Ground cover: 6 - 30 m



TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / De Haro, Guillermo

Scope of work

- Definition of the most suitable tunnelling technology between EPBm, slurry-shield and mixed-shield.
- Recommendations on tunnel geometrical requirements and TBM exploitation installations

**General information**

Location: Terrassa, Spain

Start date: 2009

End date: 2011

Client: GISA

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 6,184 km (twin tunnel)

Inner diameter: 6,90 m

Ground cover: 5 – 25 m

Description

Terrassa railway extension Project includes 4 stations and slightly more than 6 km of twin bored tunnels. Geology along the alignment includes gravel, clayey sand, sandy-clay and clay. The tunnels are in urban area passing below buildings, railways and roads. A careful and exhaustive building monitoring system has been carried out for settlement control due to TBM generated volume losses and to detect movements on buildings and other structures in the tunnel influence area.

Two EPB shield 6,90m excavation diameter have been utilised installing a 6 m, 300 mm thick precast concrete segments.

Steel fibres have been used in combination with conventional rebar for the segment concrete reinforcement.

**TC scope of work**

- Works controller and construction follow up
- Design review
- Monitoring design check and follow up
- Decision support to the Client & Engineer

TC Responsible: Bautista, Braulio

Technical staff: Vélez, Iván



General information

Location: Terrassa, Spain

Start date: 2009

End date: 2011

Client: GISA

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 6,184 km (twin tunnel)

Inner diameter: 6,90 m

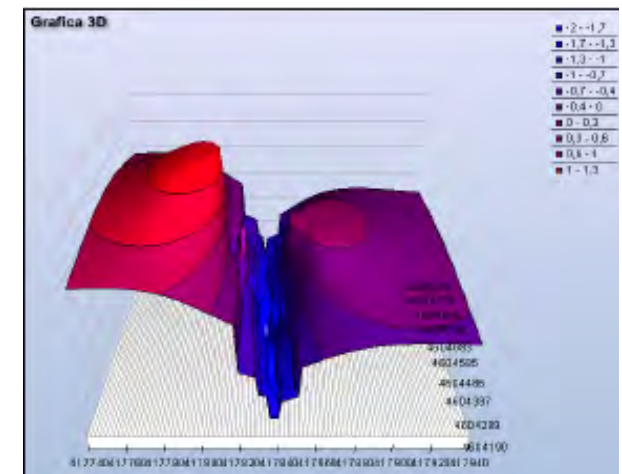
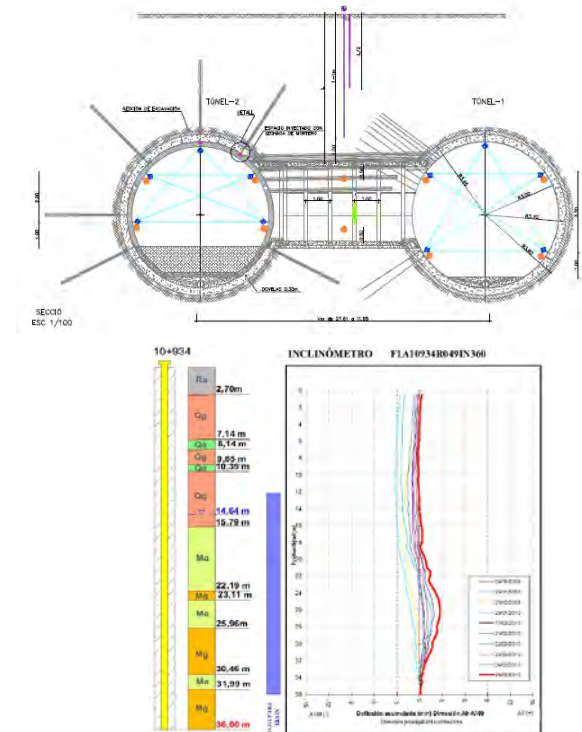
Ground cover: 5 – 25 m

Monitoring used in FCG TERRASSA Railway extension:

- To control underground excavation from surface: by monitoring arrays made up by inclinometers, rod extensometers, vibrating wire piezometers and ground settlement monitoring points distributed in longitudinal and transversal direction along the tunnel axis, according to tunnel influence area, geological profile and urban distribution.
- To control underground excavation from the tunnel: by monitoring rings made up convergence points strain gauges and load cells, to measuring strains and movements over the segments rings.
- To control shaft station excavation: by convergence points between walls and installing inclinometers, rod extensometers, load cells and strain gauges to monitoring strain ground on the structures.
- To control buildings movements: by optical survey targets based in a topographic control to monitoring settlements and angular distortion in both axes. Constant monitoring at real time.

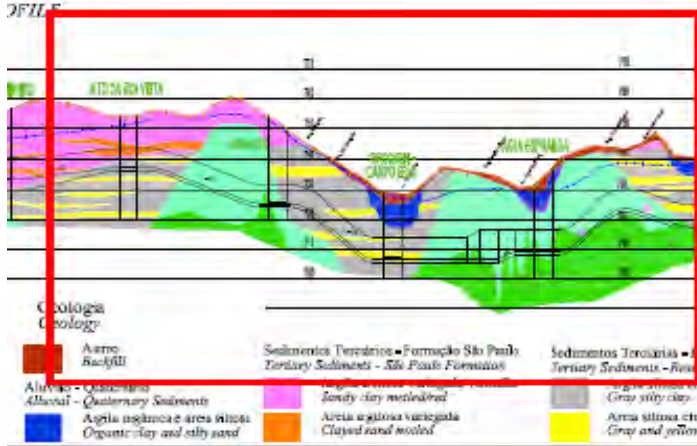
TC scope of work

- Monitoring design approval and follow up
- Works controller and construction follow up, according to monitoring measures



TC Responsible: Bautista, Braulio

Technical staff: Vélez, Iván



Description

A stretch of Line 5 of São Paulo Metrô includes the excavation of a 4930m long twin tunnel, 4 underground stations and 2 shafts (entry and exit shafts).

The tunnels will be excavated in silty-sandy clays with granular intercalations (São Paulo and Resende formations), residual material originated by Gneiss degradation (Saprolito) and weathered Gneiss rock (bedrock). Mixed conditions at the excavation face are expected.

For the design revision the following main aspects have been considered: geological heterogeneity, mixed conditions, wear due to abrasivity and minimal requested advance speed.

The proposed tunnel final lining is composed by 1500m long and 300mm thick precast concrete segments. The minimum alignment radius is 500m and the maximum slope is $\pm 4\%$.

General information

Location: São Paulo - Brasil

Start date: 2009

End date: 2009

Client: Metro Sao Paulo

Technical information

Excavation: TBM (EPB shield)

Lining: Pre-cast segments

Length: 4,9 km (twin tunnel)

Excavation diameter: 6,60 m

Ground cover: 13,5 – 30 m

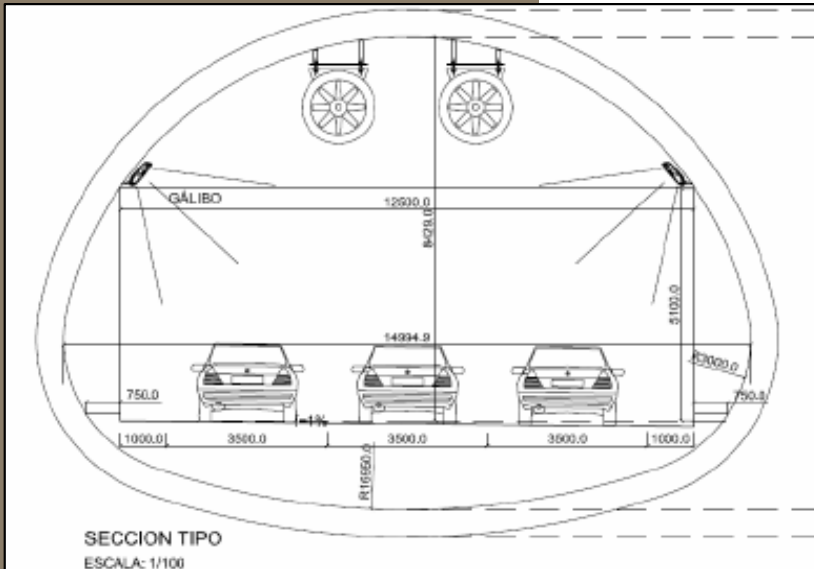


TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi

Scope of work

- Revision of the technical specifications for the tender design
- Guidelines for TBM selection and main shield characteristics.



Description

The Zapote-Curribat urban tunnel should have connected Florencio del Castillo highway to the San José ring road. The proposed solution foresees a 2500m long twin tunnels. Each tube will contain three lanes designed for heavy truck traffic. Tunnel alignment will run predominantly in lahar that is a soft rock, homogeneous, but a wide size grain curve, ranging from clay to cobbles. The section proposed is poli-centrical, composed by several tangent circles, having a carriage way width of 12,5m and a vertical clearance of 5,1 m.

General information

Location – San José, Costa Rica

Start date - 03/2009

End date – 12/2009

Client – CNC

Technical information

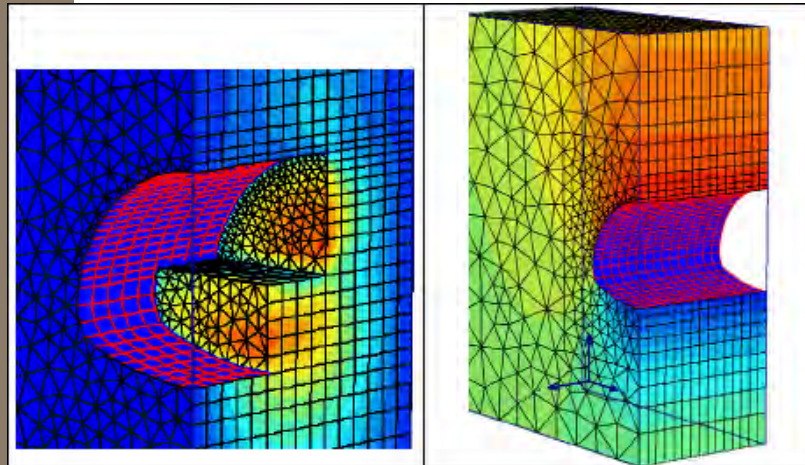
Excavation – NATM

Lining - Conventional

Length – 2,9 km

Excavated section – 148m²

Ground cover – up to 40 m



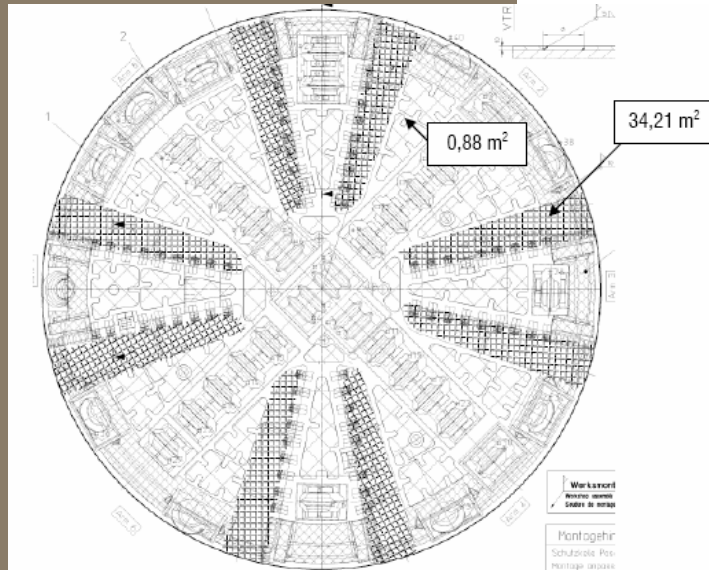
Head in charge: Della Valle, Nicola

Technical staff: Savin, Eloi / Lemos, Mariana

Scope of work

Feasibility study of the urban tunnel:

- Recommendations on tunnel geometrical requirements and installations
- Definition of the most suitable tunnelling technology
- Recommendations on tunnel temporary and permanent lining
- Risk analysis related to tunnel excavation
- Time/costs estimation
- Recommendations of required additional investigations
- Expected settlement analysis and monitoring requirement



Description

Bangalore Metro Project North-South corridor consists in the construction of twin tunnels and three underground stations. The minimum horizontal and vertical curve radii are 300m and 1500m, while the slope varies between -0.61% and 3.69%. The geological units encountered along the tunnel alignments are granites and gneissic rocks with random dykes and residual soils originated by bedrock's weathering. Mixed conditions at the front are expected for more than 50% of the alignment. Considering the grains size distribution, permeability and other relevant factors (depth, volume losses), a weighted performance balance considering EPB and Slurry shield technology has been carried out.

General information

Location : Karnataka (India)

Start date : 2009

End date : 2009

Client : Dywidag – Strabag AG

Technical information

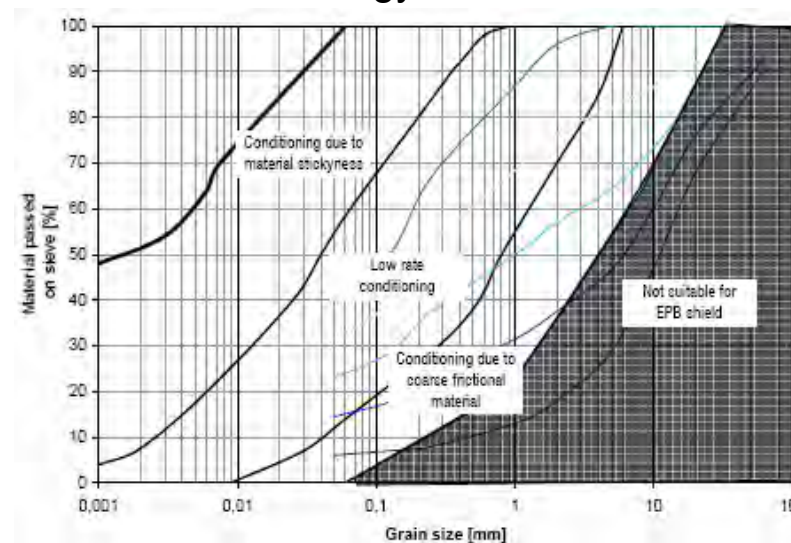
Excavation: TBM

Lining: Precast segments

Length: 3,45 km (twin tunnels)

Diameter: 5,95 m

Ground cover : 10-16 m

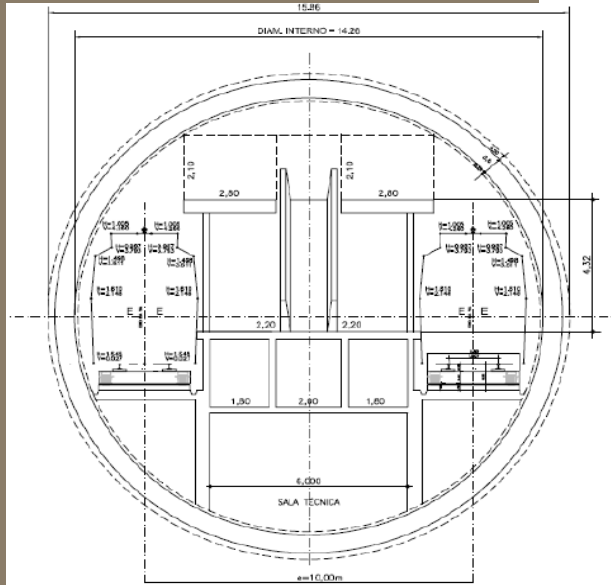


Head in charge: Della Valle, Nicola

Technical staff: Savin, Eloi

Scope of work

- Assistance to the Contractor in the election of the most suitable tunnelling technology (EPB shield or slurry-shield)
- Appraisal on the suitability of the proposed cutting wheel



General information

Location: São Paulo - Brasil

Start date: 2010

End date: 2010

Client: Metro São Paulo

Technical information

Excavation: TBM

Lining: Pre-cast segments

Length: 15,5 km

Proposed diameter: 15,86 m

Ground cover: 20 – 70 m

Description

Line 6 São Paulo Underground Project will connect northwestern part of the city to southeast, crossing under the busy downtown and Paulista Avenue. A single tube, large diameter tunnel option has been evaluated to reduce surface and underground requirements by placing the platforms inside the tunnels.

Geology along the alignment comprises gneiss characterized by different weathering grades and alluvial materials from Resende and São Paulo formations. Mixed conditions at the face are expected with a certain frequency.

A comparative analysis between different construction solutions (traditional method, large diameter TBM and medium diameter TBM) has been carried out to support the choice of the most recommendable method.



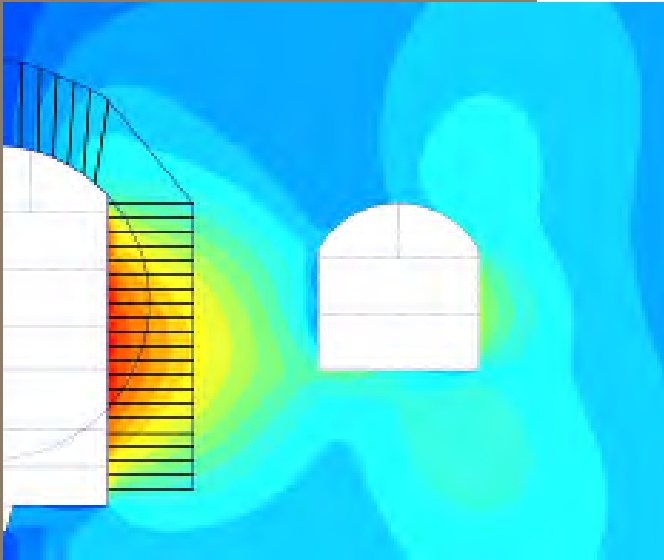
TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi

Scope of work

Feasibility study including:

- Recommendations on most suitable TBM shield method
- Recommendations on tunnel (and stations) geometrical requirements
- Proposal of an excavation sequence
- Expected settlement analysis
- Risk analysis related to tunnel excavation by different methods
- Time estimation considering large and medium diameter tunnel solutions



Description

Nido de Águilas Hydroelectric Project is located in the Cachapoal province at southeast of Santiago. It comprises a 11km long headrace tunnel, two intake structures and a single underground cavern hosting two Pelton turbines. The plant will have an installed capacity of 155MW and the flow will be taken both from both Cortaderal River ($36\text{m}^3/\text{sec}$) and Las Leñas River ($10\text{m}^3/\text{sec}$).

Tunnel alignment will cross a massif whose geology mainly consists of sequences of andesites and pyroclastic rocks; two granitic intrusive bodies composed of monzonites and granodiorites shall be crossed as laying along the alignment.

General information

Location - Chile

Start date – 01/2010

End date – 10/2010

Client – Gianfranco Perri

Technical information

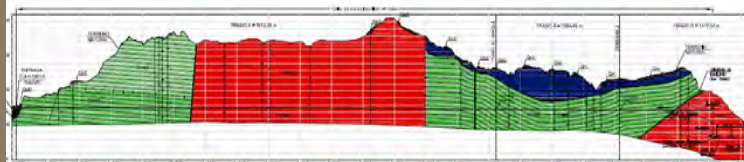
Excavation – TBM and D&B

Lining – Precast segments & conventional

Length – 11,0 km

Diameter – 5,00 m

Ground cover – up to 1.300 m



Scope of work

- Detailed assessment of the geological conditions expected along the updated tunnel alignment
- Proposal of different constructive schemes taking into account the risks connected with the TBM excavation
- Detailed assessment of the most suitable TBM technology to be employed
- Basic design for cost evaluation of tunnels and powerhouse cavern, temporary support and final lining for scheduling & cost evaluation purposes.

Head in charge: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Salas Monge, Regina



General information

Location - Chile

Start date – 06/2010

End date – In progress

Client – ENDESA Chile

Technical information

Excavation – Double shield

TBM and D&B

Lining – Precast segments &
conventional

Length – 12,0 km

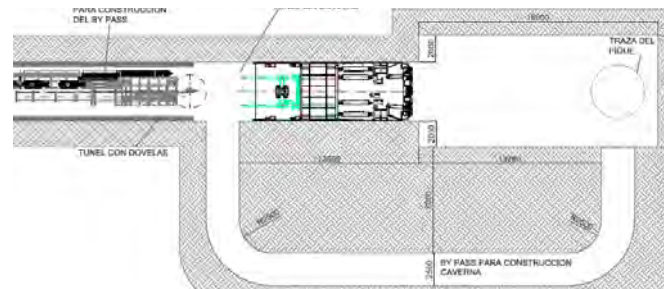
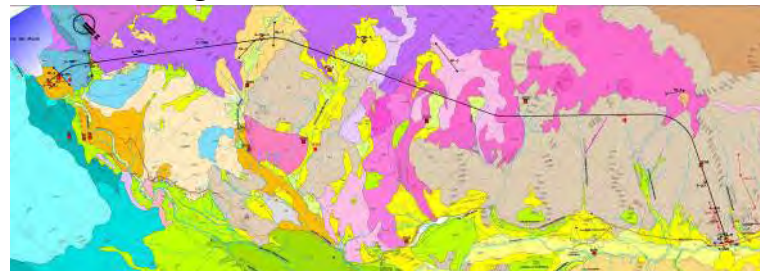
Inner Diameter – 3,70 m

Ground cover – up to 1.300 m

Description

Los Cóndores Hydroelectric Project is located in the Maule Region, 200km south of Santiago. It comprises a 12km long headrace tunnel, a 480 long vertical pressure shaft, and a single underground powerhouse hosting two Pelton turbines for a total installed capacity of 148MW. The run off the river flow will be derived from existing Maule Lagoon (25m³/sec).

Tunnel alignment will cross a massif whose geology mainly consists of sequences of andesites, basalts and piroclastics rocks; a dacitic intrusive body and tuff rocks will be encountered along the alignment.



Scope of work

- Detailed assessment of the geological conditions expected along the updated improved tunnel alignment
- Proposal of different constructive schemes taking into account the risks connected with the TBM excavation
- Detailed assessment of the most suitable TBM technology to be employed
- Basic design of headrace tunnel and, temporary support and final lining for scheduling & cost evaluation purposes.
- Drafting of technical specifications for Project Tender

Head in charge: Della Valle, Nicola

Technical staff: Savin, Eloi / Salas Monge, Regina / Babbucci, Silvia / Montobbio, Daniel



Description

The Ankara – Istanbul High-speed Line Project, includes the construction of a completely new double track electrified high-speed rail line, fit for speed up to 250 km/h. Tunnel number 26 will be excavated with an open shield 13,75 m E.D. equipped with screw conveyor for material extraction. Geology basically consists in graphitic schist and chlorite schist with marble blocks. The structural lining design has been carried out following Eurocode 2 and relevant international standards, including highly demanding seismic design requirements. The tunnel is being lined by 2,0m long and 45cm thick precast concrete segments for a 12,5 m inner diameter.

General information

Location: Eskisehir, Turkey

Start date: 2010

Client: Cengiz – IC İktas - Belen
Joint Venture

Technical information

Excavation: HR Shield

Lining: Precast segments 7+1UR

Length: 5,4 km

Excavation diameter: 13,75 m

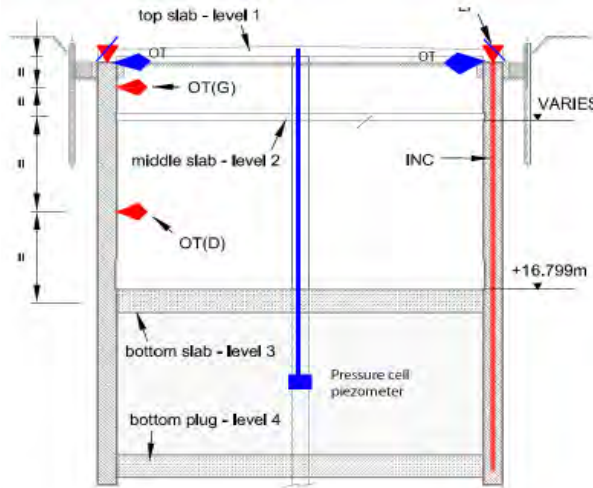


TC Responsible: Della Valle, Nicola

Technical staff : Savin, Eloi / Francesco Tagliatela

Scope of work

- Support to JV for TBM contract definition
- Follow up of TBM manufacturing until commissioning
- Geometrical and structural lining design, considering fibre reinforced concrete
- Method statement for TBM launching.
- Assistance during tunnel excavation.



General information

Location: Warsaw (Poland)

Start date: April 2010

End date:

Client : AGP METRO

Technical information

Excavation: TBM (EPB)

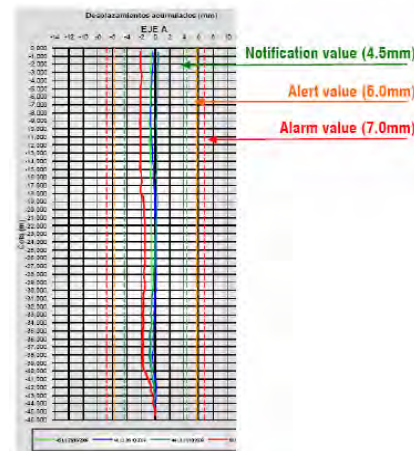
Lining: Precast segments

Length: 2 x 4,529 km

Ground cover: 10-30 m

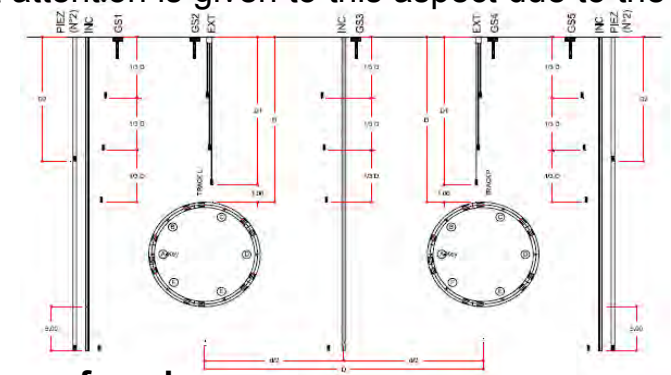
Monitoring system design for Warsaw underground – Line II project:

- To control ground surface: geodetic control sections formed by 7 surface levelling points will be spaced 5-20m between them for topographic measurements.
- To control in-ground deformations: deformation control sections equipped with inclinometers, rod extensometers, piezometers and leveling points, are spaced 200m.
- To control segmental lining: 9 instrumented rings equipped with convergence targets and strain gauges are foreseen along the alignment.
- To control stations excavation: by inclinometers and optical targets installed at station walls, piezometers and ground settlement monitoring points.
- To control buildings movements: three influence zones have been defined around the tunnel alignment and stations. An intensive topographic control consisting on manual and automatized measurements is foreseen, furthermore than the installation of crackmeters, wall inclinometers and 3D accelerometers.
- To control underground water table: Utmost attention is given to this aspect due to the proximity of the project area to Vistula River.



TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia



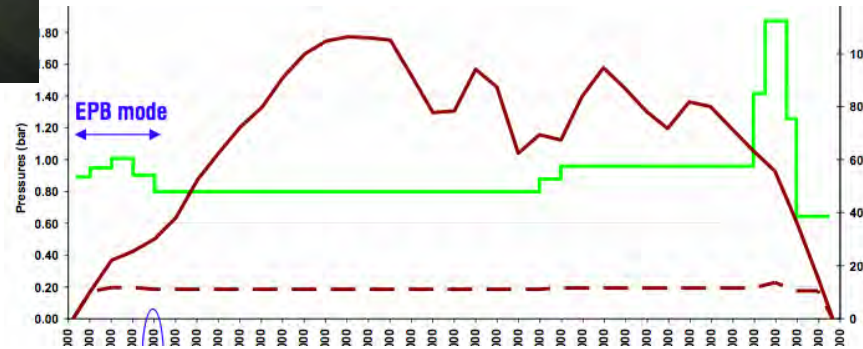
Scope of work

- Revision of ground and building monitoring plan with relevant recommendations
- General instruction for the monitoring plan organization and definition of procedures
- Appraisal reports on segmental lining geometrical and reinforcement design



Description

Aked tunnel No. 1 is the first of several tunnels part of the new Jerusalem-Tel Aviv High speed railway line. It consists in 3.5 km long twin tunnels joined by fourteen emergency cross passages that will be bored mainly in the chalk, marl, chalky marl, marly chalk and clay of the Taquiye formation. An Earth Pressure Balance (EPB) TBM which applies pressure to the front will be used for the excavation of the Aked tunnels. The TMB will also install a segmental lining consisting of 9,0 m i.d. rings and 500 mm thick segments.



General information

Location: Israel

Start date: 2010

End date: ongoing

Client: Mosmetrostroy-Minrav JV

Technical information

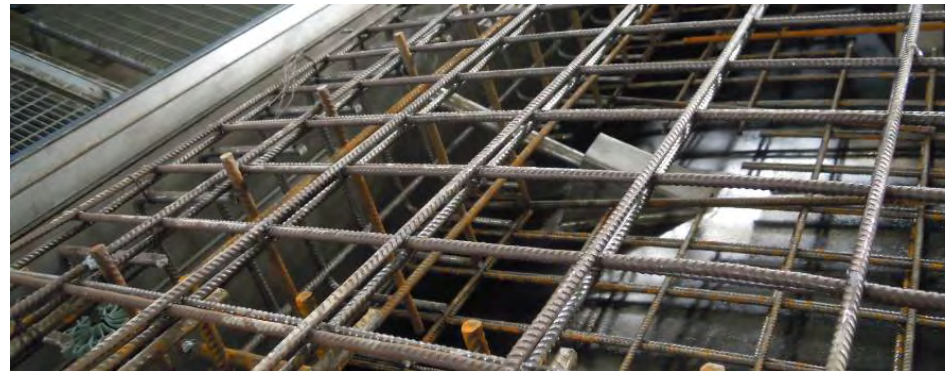
Excavation: TBM (EPB)

Lining: Precast segments

Length: Twin 3,5 km long tubes

Excavation diameter: 10,3 m

Ground cover: up to 112 m

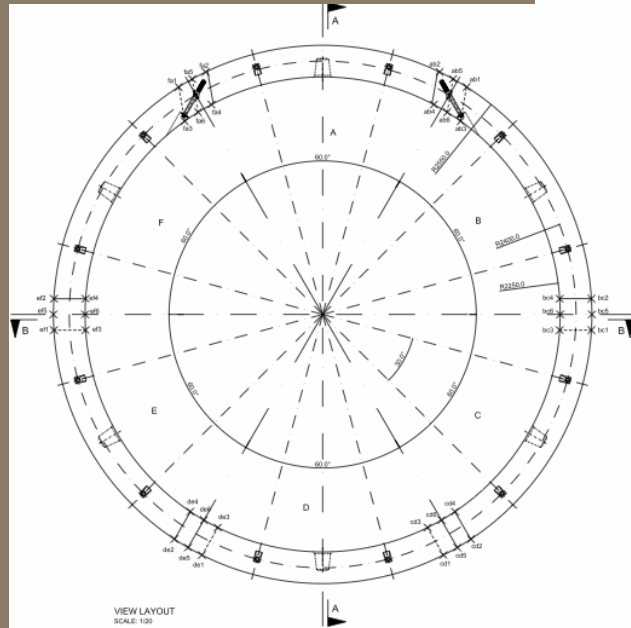


TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Salas, Regina /
Savin, Eloi / Taglialatela, Francesco

Scope of work

- Tunnel face stability study and EPB pressure computation
- Definition of tail mortar and soil conditioning requirements
- Precast segmental lining geometrical design and structural verification
- Technical specifications for lining fabrication and installation, backfill annulus grouting and sealing and connection systems
- Cross passages construction stages definition and structural design
- Tunnel monitoring design



Description

The Ankara water supply project will deviate the Gerede river through the construction of a weir and a tunnel that will transfer the water to the area of the Çamlıdere Dam. The planned tunnel is a free-flow conduit, 31.6 km long with an inner diameter of 4.5 m which gives it a transport capacity of 40m³/s. Due to geological conditions two different types of lining are foreseen: 350 mm and 300 mm thick. In addition, due to the high expected water pressures the waterproofing design was critical since it had to be watertight up to 10 bar and at the same time guarantee water ingress into the tunnel at that pressure. The lining has also been designed with a pressure relief valve located in the pea-gravel injection hole.

General information

Location: Ankara, Turkey

Start date: 2011

End date: ongoing

Client : Yüksel Proje

Technical information

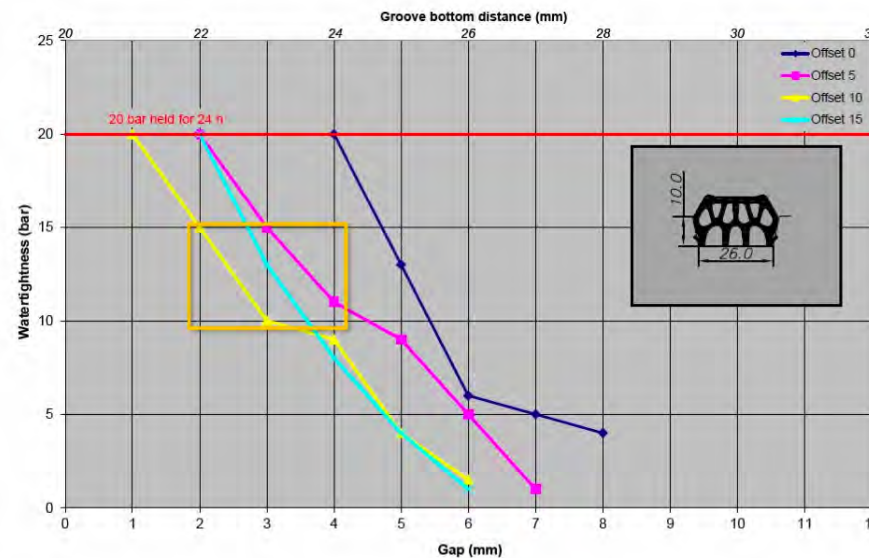
Excavation: TBM (Double shield)

Lining: Precast segments

Length: 31,6 km

Excavation diameter: 5,475 m

Ground cover: up to 600 m

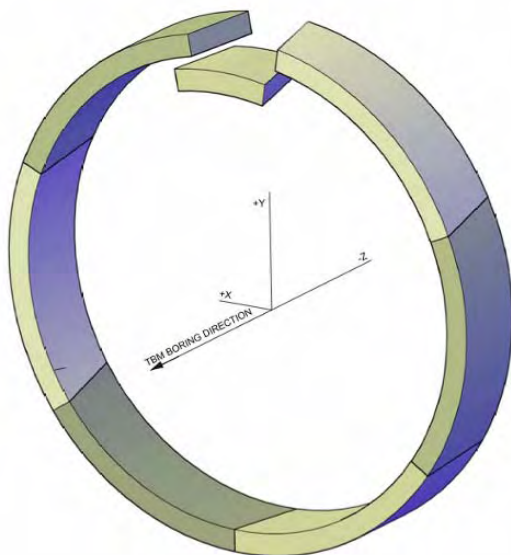


TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina

Scope of work

- Precast segmental lining geometrical design for both ring types.
- Revision of segment formwork designs.
- Waterproofing design and technical support in gasket design and selection.
- Technical support in pressure release valve specification.



Description

The Kargi Hydropower Project headrace tunnel will be excavated in the medium to very poor quality rock masses of the Kunduz metamorphic formation and Kirabasj complex. This 11.7 km long tunnel will be excavated with a Double Shield TBM installing a rectangular/trapezoidal segmental lining with 8,7 m i.d. and 40 cm thick segments. Due to space and access constraints, the TBM shall be launched from a temporary adit and extracted at the 14.9 m wide shaft excavated for the stop logs gate structure. Minimum curvature radius is 800m.

Scope of work

- Design of tunnel alignment to make it compatible with the planned execution methodology and with the selected Double Shield TBM characteristics
- Precast segmental lining geometrical design and structural design
- Definition of DS TBM technical specifications. Follow up of TBM construction and commissioning

General information

Location: Kargi, Turkey

Start date: 2010

End date: ongoing

Client : Gülermak

Technical information

Excavation: TBM (Double shield)

Lining: Precast segments

Length: 11,7 km

Excavation diameter: 9,8 m

Ground cover: up to 600 m



TC Responsible: Della Valle, Nicola
Technical staff: Salas, Regina / Savin, Eloi



Description

The Toronto-York Spadina Subway Extension Project (TYSSE) will provide a critical extension for the existing Toronto Transit Commission (TTC) subway system across the municipal boundary between the City of Toronto and The Regional Municipality of York (York Region).

There are six stations sites currently planned from Sheppard Avenue West, to Vaughan Corporate Centre.

The planned service levels, implies one train every 4 minutes.

To encourage commuters to use the subway system, 2,900 new parking spaces will be built at three stations along the extension.

Subway service is expected to begin in 2015.

General information

Location: Toronto (Canada)

Start date: 2010

End date: 2011

Client : OHL

Technical information

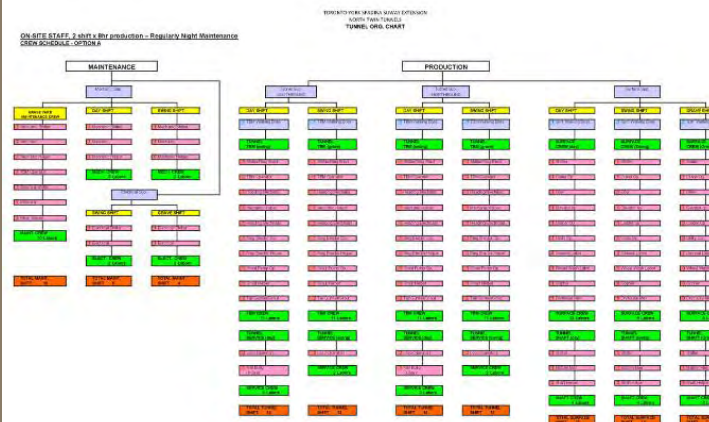
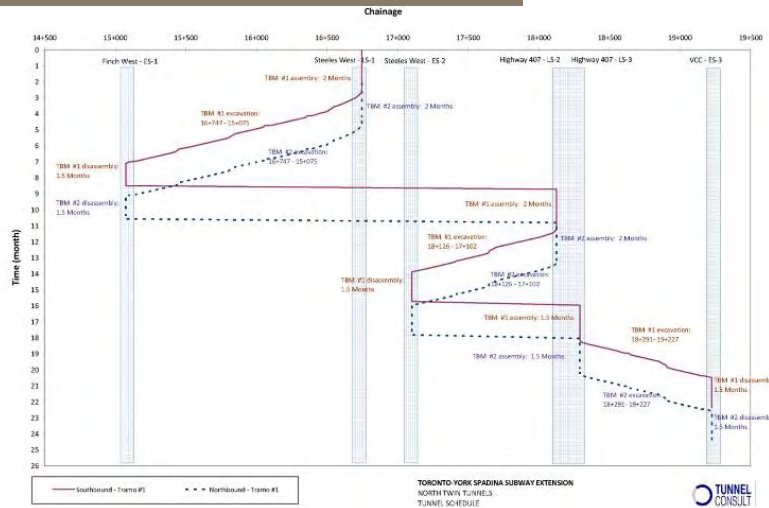
Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 2 x 8,6 km

Internal diameter: 5,50 m

Ground cover: 10-20 m

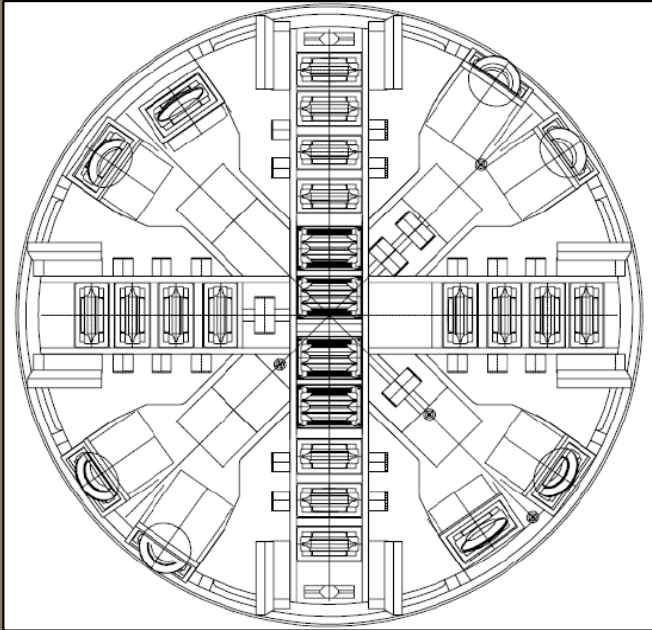


TC Responsible: Della Valle, Nicola

Technical staff: Montobbio, Daniel

Scope of work

- Works planning
- Monthly and weekly working shift arrangement
- Daily planning of excavation works
- Tunnelling works sequence study
- Study of the 3 basic cycles which form the logistic chain of the TBM production
- Shift personnel arrangement

**General information**

Location: New Delhi, India

Start date: 2010

End date: 2010

Client : Larsen & Toubro Ltd.

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 2,9 km

Excavation diameter: 5,11 m

Ground cover: 14 m – 60 m

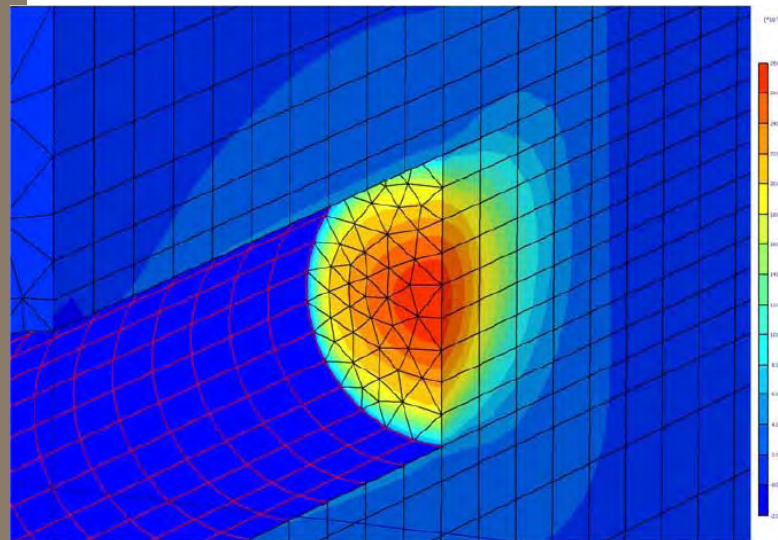
Description

The CMC-1 tunnel, located in a highly urbanized area nearby to the Safdarjung Airport in New Delhi (India), is part of the Delhi Mass Rapid Transport System (MRTS) Project.

A complex geological-geotechnical context, with presence of hard silts, quartzitic bedrock and mixed rock-soil conditions at the excavation face, is expected during the TBM EPB drive; therefore the definition of the proper EPB shield excavation mode and working pressures and of the suitable soil conditioning actions is of the utmost importance.

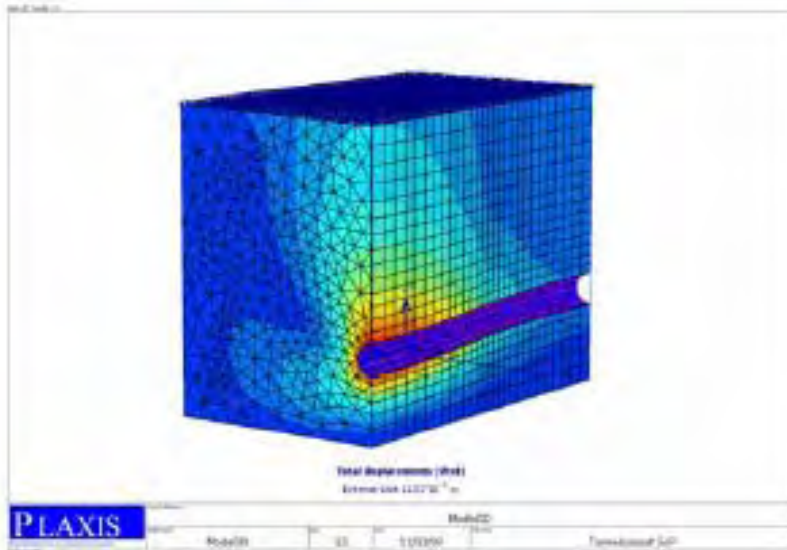
Scope of work

- Detailed study of the expected ground geological-geotechnical conditions
- Definition of the proper EPB shield excavation mode for the various expected ground conditions (i.e. open mode, semi-closed mode, closed mode)
- Definition of the EPB closed mode working pressures along the alignment
- Verification of the EPB closed mode recommended working pressures with 3D numerical models
- Definition of the proper soil conditioning actions to be performed at the EPB shield cutterhead and in the excavation chamber



TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi



Description

Riachuelo Sewer Treatment Plant Project is part of the Integral Sanitation Plan of Buenos Aires City and includes the construction of a 10km long outfall tunnel below River Plate.

Geology of the area comprises clayey deposits of Plata River, silt-clayey soils of Pampean formation and dense mica sands of Puelchense formation.

A two step lining has been foreseen with precast segment rings and inner 15cm thick secondary lining. Relevant aspects, like planning, shafts, proposed alignment, segmental lining and mortar, have been analysed. Furthermore an indicative cost for linear metre of tunnel has been estimated taking into account needed human resources, materials and equipments as well as average advance speeds.

Scope of work

Consulting on mechanized tunnelling that included:

- Definition of the most suitable tunnelling technology taking into account technical, economical and time related aspects
- Definition of a post tensioned segmental ring to withstand inner pressures in soil with poor geo-mechanical qualities
- Construction sequence study
- Revision of tender documents

General information

Location: Buenos Aires
(Argentina)

Start date: 2008

End date: 2009

Client : AYSA

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: (12,4+2,2) km

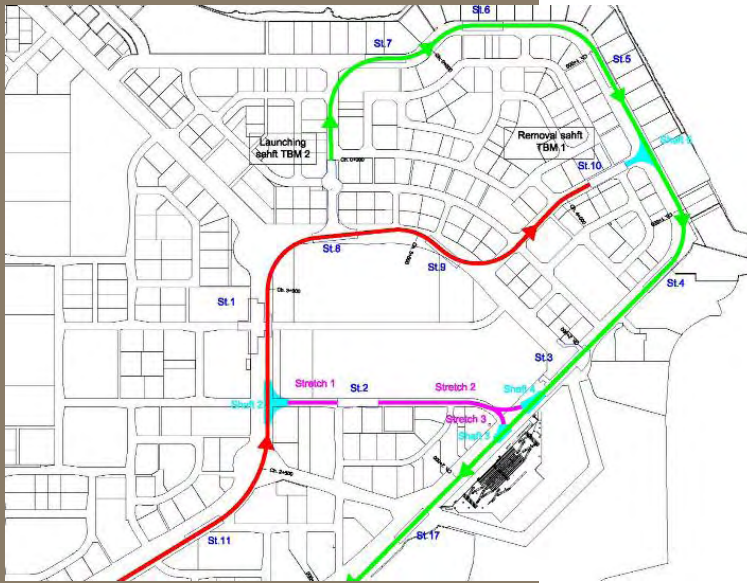
Inner diameter: variable (1,7-3,8 m)

Ground cover: 16-25 m



TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi / Montobbio, Daniel



General information

Location: Doha (Qatar)

Start date: 2011

End date: 2011

Client : Gulermak

Technical information

Excavation: TBM (slurry shield)

Lining: Precast segments

Length: 11,0 km

Excavation diameter: 9,70 m

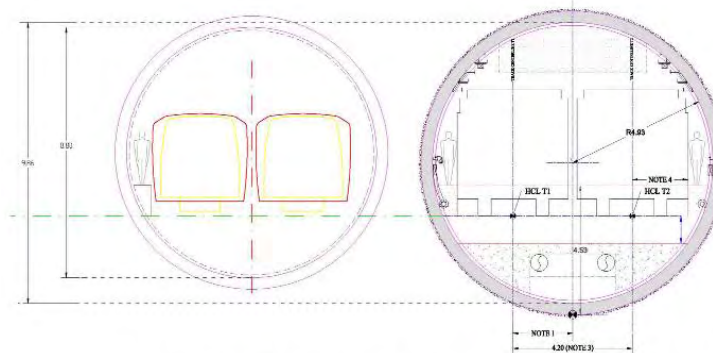
Ground cover: 20-30 m

Description

The “Automated People Mover (APM) Project” consists in an underground network of automated trains that will satisfy the expected mobilization demand by substantially improving the public transport in the Doha West Bay area. Foreseen APM System is characterized by high capacity and frequency.

Doha, Qatar's capital city is located in the Arabian Peninsula and surrounded by the Persian Gulf.

The main geological units in Qatar consist in carbonated sediments with different ages that form the Arabian Gulf Basin (or Arabian Shelf), overlaying the igneous and metamorphic rocks basement (Arabian Shield). The Tertiary sediments of the Arabian Shelf are covered by Quaternary deposits composed of silty sand with gravel and cobble of limestone with shell fragments.



TYPICAL SECTION WITH APM
SYSTEM CITYVAL

TYPICAL SECTION IN DOHA

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Montobbio, Daniel

Scope of work

- Study of the available documents and geological conditions
- Selection of train dimensions and clearances
- Definition of tunnel dimensions
- Geometrical pre-design of the segmental lining
- Selection of the most appropriate TBM system (EPB, HR or Slurry Shield)
- Definition of different construction sequences and work scheduling



Description

Berazategui Sewer Treatment Plant Project is part of the Integral Sanitation Plan of Buenos Aires City and includes the construction of a 4km long outfall tunnel below River Plate.

Geology of the area comprises clayey deposits of Plata River, silt-clayey soils of Pampean formation.

A two step lining has been foreseen with precast segment rings and inner 15cm thick secondary lining. Relevant aspects, like planning, shafts, proposed alignment, segmental lining and mortar, have been analysed. Furthermore an indicative cost for linear metre of tunnel has been estimated taking into account needed human resources, materials and equipments as well as average advance speeds.

General information

Location: Berazategui - CABA (Argentina)

Start date: 2011

End date: 2011

Client : AySA

Technical information

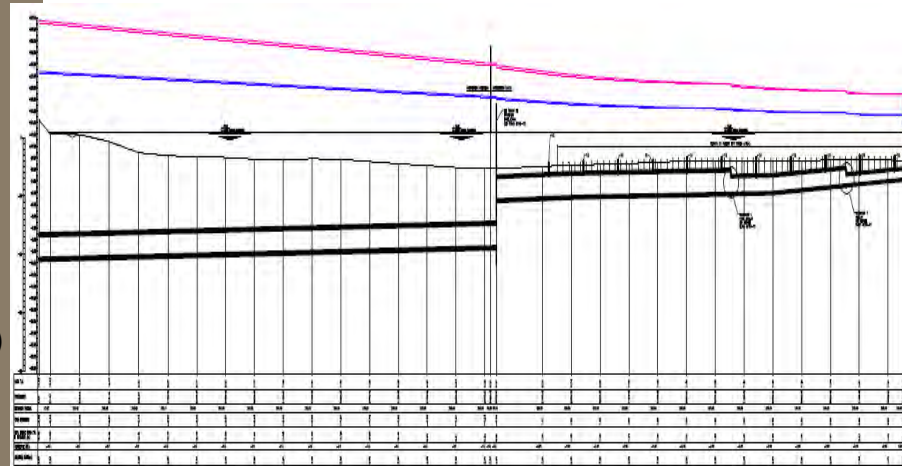
Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 3,97 km

Inner diameter: 4,4m

Ground cover: 12-16 m



TC Responsible: Della Valle, Nicola

Technical staff: Savin, Eloi / Montobbio, Daniel

Scope of work

Consulting on mechanized tunnelling that included:

- Definition of the most suitable tunnelling technology taking into account technical, economical and time related aspects
- Definition of a post tensioned segmental ring to withstand inner pressures in soil with poor geo-mechanical qualities
- Construction sequence study
- Revision of tender documents



General information

Location: Chennai (India)

Start date: 2011

End date: 2011

Client : Transtunnelstroy –
Afcons JV

Technical information

Excavation: TBM (EPB & slurry
shield)

Lining: Precast segments

Length: 2 x 18,3 km

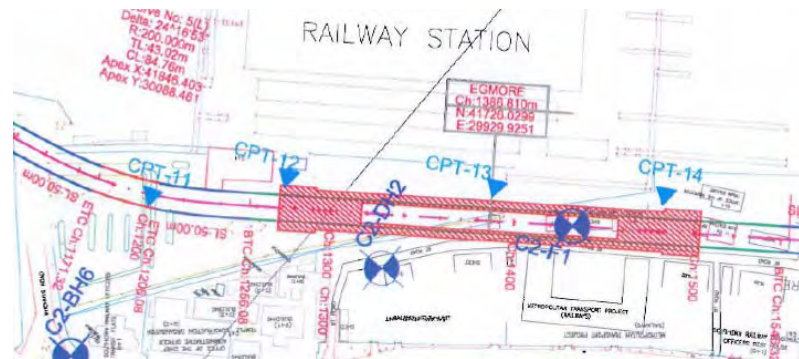
Ground cover: 20-30 m

Description

The proposed first stage of Chennai Metro Rail Project includes the design and construction of two corridors, Corridor 1 - Washermanpet to Airport and Corridor 2 – Chennai Central to St. Thomas Mount.

Corridor 1 is about 23.06km of which 14.26km is underground and the remaining 8.8 km is elevated. Corridor 2 is some 21.96 km in length and partly underground up to Km 9.5 and the balance is elevated. The project is considered accessible by all modes of road transport for all seasons.

The project area lies within the Peninsular India which generally comprises Archean Rocks (Granites and Gneisses) as well as fossiliferous rocks intercalated in some places with marine beds of Neocomian age (shale and sandstone). These formations have been found intersected by Doleritic dykes and are covered generally with younger alluvium of varying thickness of 3.00 m to 30.00 m or more as found during the investigations.

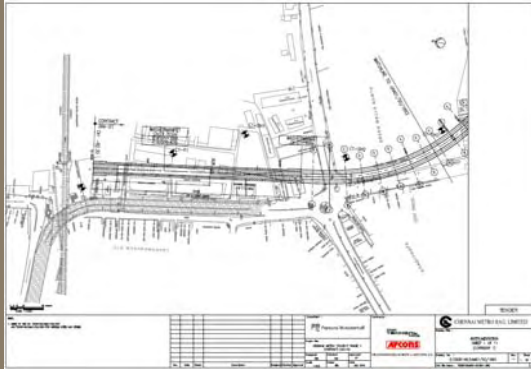


TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Montobbio, Daniel

Scope of work

- Soil investigation program site supervision
- Revision of geological-geomechanical conditions
- Revision of tunnel monitoring basic plan



General information

Location: Chennai (India)

Start date: 2011

End date: 2011

Client : Transtunnelstroy –
Afcons JV

Technical information

Excavation: TBM (EPB & slurry
shield)

Lining: Precast segments

Length: 2 x 18,3 km

Ground cover: 20-30 m

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia

Montobbio, Daniel

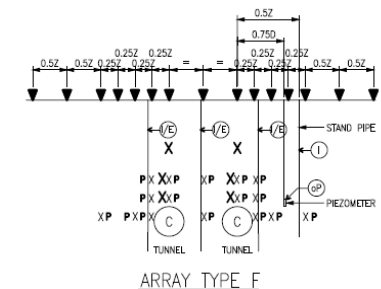
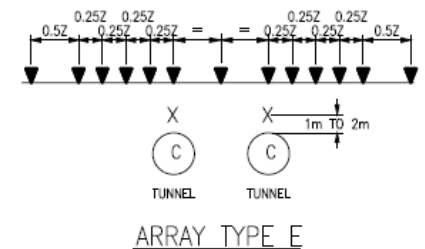
Monitoring defined for Chennai Metro Rail Project:

• To control underground excavation from surface: should be controlled by monitoring transversal arrays made up by inclinometers, rod extensometers, vibrating wire piezometers, convergence measurements and ground settlement monitoring points, and ground settlement monitoring benchmarks arranged in longitudinal direction along the tunnel axis, distributed according to tunnel influence area, geological profile and urban distribution.

• To control TBM break-in and break-out locations: should be monitored with several instruments such as station wall inclinometers, rod extensometers on both tunnel axes, piezometers and ground settlement monitoring points.

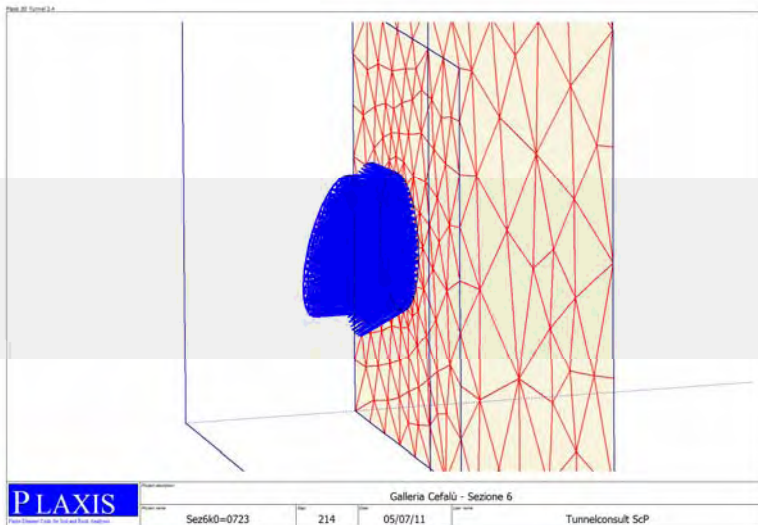
• To control cross passage sections: advise use rod extensometer with an array of ground settlement points (between 5 to 7 units) along the CP alignment.

• To control buildings movements: should be based in a topographic control consisting on manual measurements of optical survey targets installed on buildings.



Scope of work

- Revision of adopted ground and building monitoring plan with relevant recommendations
- Building damage risk assessment and building monitoring
- Site assistance for monthly reporting on local or remote basis



General information

Location: Cefalù, Sicilia (Italia)

Start date: 2011

End date: 2011

Client : GLF & Impresa

Technical information

Excavation: TBM

Lining: Precast segments

Length: 2 x 6,7 km

Excavation diameter: 9,90 m

Max. Ground cover: 135 m

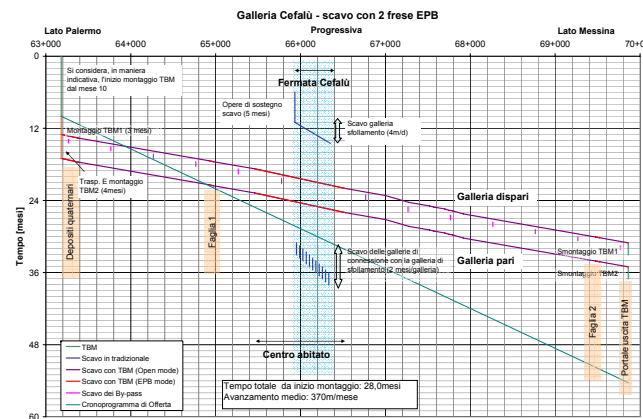
Description

“Cefalù tunnel” represents the main subterranean work within the context of the “Doubling Railway Line Project – lot Ogliastrillo - Castelbuono”. It consists of a twin tunnel formed by two tubes each 6,7km long. Furthermore the works include the construction of the underground “Cefalù Station” and the excavation of 13 by-passes along the tunnel alignment.

Cefalù city is located on the northern coast of Sicily, characterized by karstic morphology and carbonate rocks. The main geological units crossed by the tunnel alignment are two sub-units of “Flysch Numidico formation”: quartzarenitic litofacies composed of quartzose arenites and quartzose siltites and pelithic-arenaceous litofacies formed by argillites alternating with thin layers of quartzose arenites and quartzose siltites. At the West Portal, along the initial 200m long stretch detritic materials are encountered.

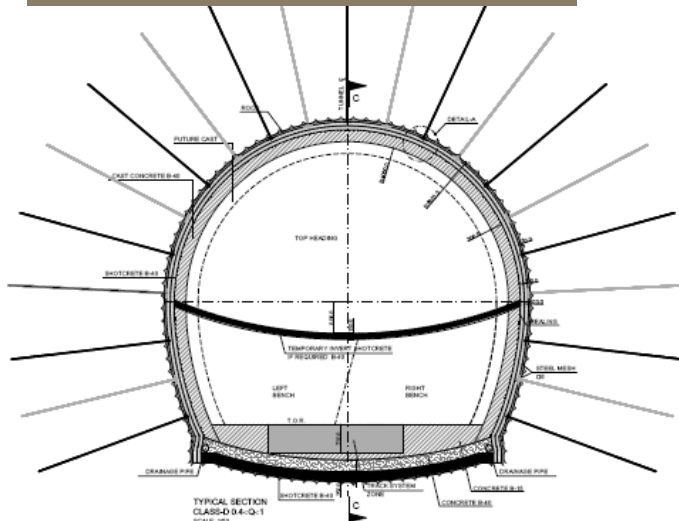
Scope of work

- Study of the geological conditions
- Proposal for the optimization of the segmental lining geometry
- Selection of the most appropriate TBM system
- Stability face analysis, including EPB pressure computation
- Construction time schedule estimation



TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Savin, Eloi



General information

Location: Karmiel (Israel)

Start date: 2011

End date: 2011

Client : Minrav-MosMetroStroy

Technical information

Excavation: Conventional method (NATM)

Lining: Conventional support

Length: 2 x 4,625 km

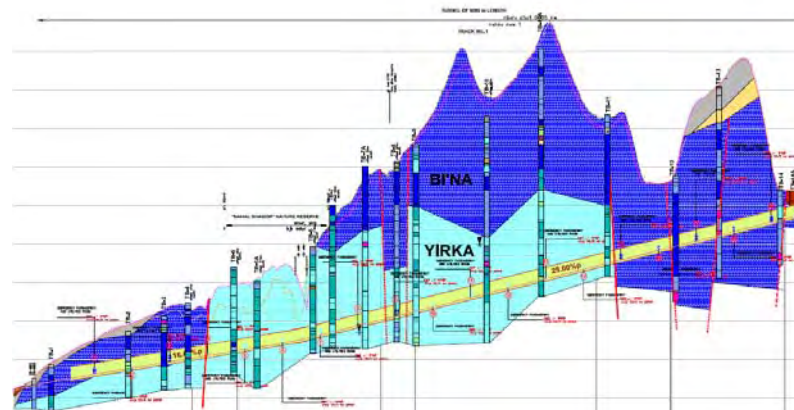
Ground cover: 12 - 160 m

Description

Gilon tunnel forms part of “Akko-Karmiel Railway” Project. It is a twin tunnel, 5km long, that includes 19 connection tunnels. The tunnel alignment crosses Gilon Mountain with a maximum overburden of 160m, while the minimum overburden corresponds to 12m at the Wadi Shagor River crossing.

Within the project area, geology basically consists of two main lithologies: “Bi’na formation” that is formed by massive limestone and limestone interbedded with thin layers of marl and “Yirka formation” composed by limestone interbedded with chalk and chert nodules.

On the basis of estimated construction time comparison, it resulted that the most suitable excavation technology is represented by the conventional method (both “Drill and Blast” and mechanical excavation by hydraulic hammers and roadheaders).



Scope of work

- Assessment on the most suitable excavation technology (TBM or conventional method)
- Identification of the support classes in function of the rock quality
- Estimating Bill of Quantity (BoQ)

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Montobbio, Daniel / Savin, Eloi



General information

Location: Barcelona (Spain)

Start date: 2011

End date: 2012

Client : TMB (Transportes
Metropolitans de Barcelona)

Technical information

Excavation: Conventional method
(NATM), Tunnel Boring Machine
(TBM), Cut and Cover

Lining: Conventional support,
precast segments, cast in place

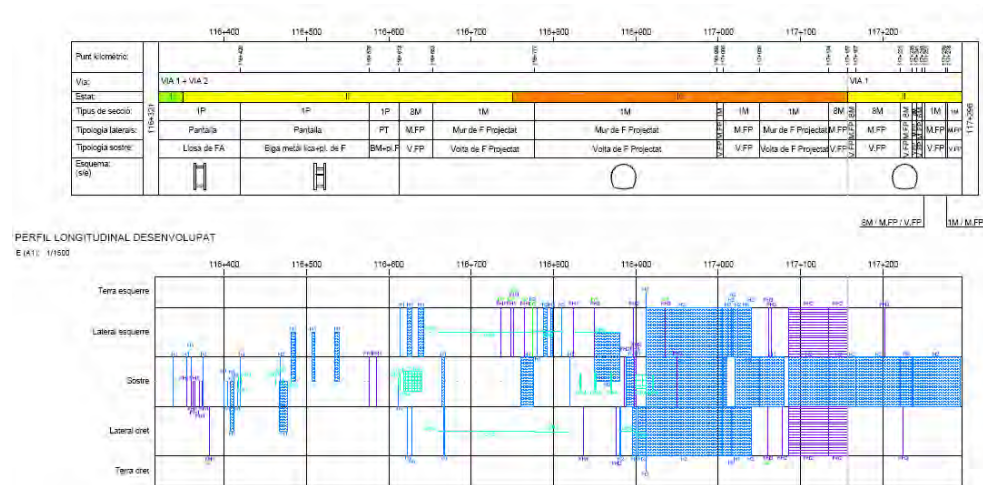
Length: 30 km

Description

Barcelona Underground Metro network has more than 100km of tunnels built from 85 years ago to these days. TMB is the responsible for the public passenger transport services such as construction, operation and also maintenance.

Under operation stage, tunnels deteriorate themselves due to environmental conditions, water leakage or structural loading changes, being the main encountered deficiencies cracks, spalling, staining, corrosion on steel members, hollow areas, debris, efflorescence and leakage.

Periodic tunnel inspections must be launched to define maintenance or repair campaigns where the tunnel suffers serious structural damages or deficiencies affect the daily metro operation.

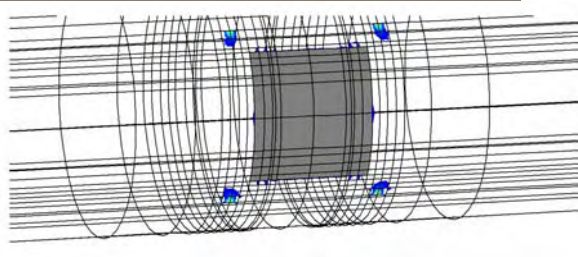
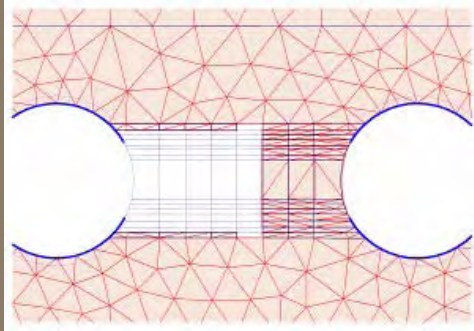


Scope of work

- Data reviewing: available tunnel drawings, as built projects and previous inspection reports
- Planning, scheduling and inspection forms development
- Tunnel visual inspection
- Database transferring and deficiencies drawings

TC Responsible: Montobbio, Daniel

Technical staff: De la Iglesia, Marcos / Bech, Sara



General information

Location: Istanbul, Turkey

Start date: 09/2011

End date: 04/2012

Client: Gulermak Dogus JV

Technical information

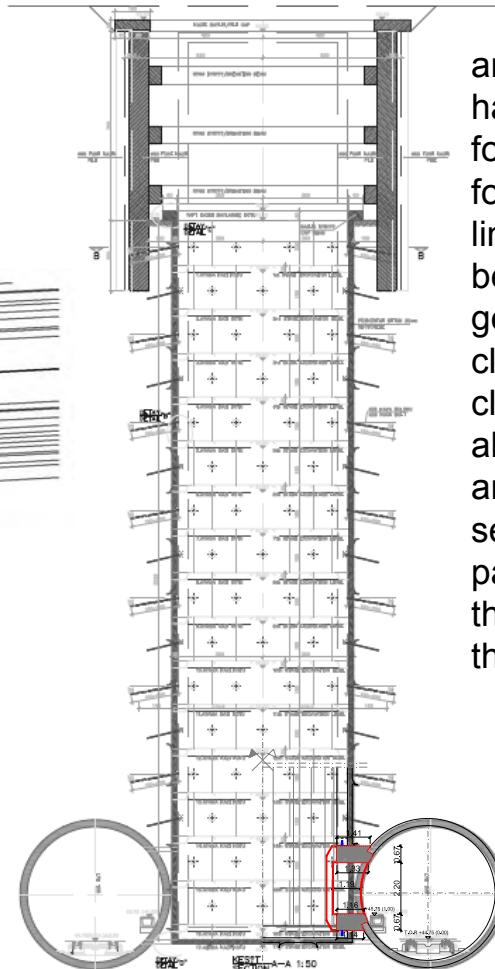
Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 17 km (twin tunnel)

Excavation diameter: 6,56 m

Ground cover: 25 – 50 m



Description

Within the context of “Otogar-Bagcilar (LRT)” and “Basak Konutlari 4 – Kirazli (MRT)” metro lines projects, it has been entrusted to Tunnelconsult the technical assistance for the execution of the ventilation and emergency shafts foreseen along the lines. The analyzed stretches of the metro lines sum up a length of 17Km and a total of 10 shafts have been designed. Geology at the shafts areas includes various geological conditions ranging from rock types (limestone, claystone, marl and shale) to over consolidated sands and clay. In particular the influence of the shafts excavation on the already excavated segmental lining tunnel has been analyzed, proposing the methodology to safely open the segmental lining and execute the shafts connection and cross passages. Furthermore Tunnelconsult designed the collar of the cross passages for both rock and soil conditions, verifying the necessity of shear keys and/or and steel bracing.

Scope of work

- Appraisal report on geological and geotechnical characterization at shaft and cross passage areas
- Technical assistance for the construction of the shafts and cross passage
- Structural verifications of the cross passages collar
- Design of the steel bracing and shear keys for the opening of the segmental lining tunnel

TC Responsible: Nicola Della Valle

Technical staff : Babbucci, Silvia / Savin, Eloi / Taglialatela, Francesco



General information

Location: Ankara, Turkey

Start date: 2011

End date: 2011

Client: Impresa – Özdoğanlar –
Gülsan JV

Technical information

Excavation: S-324 EPB shield
machine

Lining: Precast segments

Length: 9250 m of twin tube

Inner diameter: 5.24 m

Ground cover: 4-55 m

Description

Tandogan-Keçiören Metro Line Project of the Ankara Metro Line 4 consists in the excavation of a twin tube of 9250m length approximately including 9 stations, 140m long each. Excavation works began in 2006 but they were stalled due to lack of funds. In 2011 a tender was launched to award the completion of the works in progress.

The majority of tunnel alignment was been executed by employing a TBM and crossovers and stations were constructed by the cut and cover method. The tunnel section has an inner diameter of 5.24m and a 260mm thick as a segmental lining ring installed as permanent support. The TBM, S-324 shield manufactured by Herrenknecht which excavated the existing drives was located at Diskapi station, together with 1325 rings stocked in different places.



Scope of work

- Detailed analysis of the available geological information along the alignment.
- Recommendations on the suitable TBM arrangement.
- Indications on suitable TBM alternatives eventually available on the market (location and approximate cost).
- Technical support to estimate TBM excavation cost.

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Salas, Regina / Montobbio Daniel

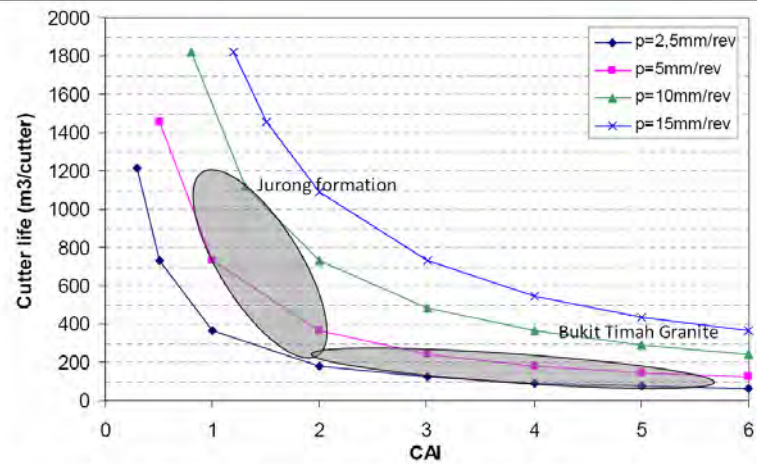


Figure 5-2 Estimated Cutter wear rate with the CSM model for 17" diameter cutters.

Description

Contract 1 of the East-West transmission cable tunnel comprises the construction of a total of 4114 m of tunnel as well as three shafts. It is foreseen that the tunnel will be excavated with two (2) TBMs which must be capable of applying pressure to the tunnel face. The tunnel will be lined with a 300 mm thick segmental lining with 6.0 m internal diameter and 6.6 m external diameter. The tunnel of Contract EW1 will be excavated in two different geological formations: sedimentary Jurong formation and the highly abrasive Bukit Timah Granite.

Scope of works

- Detailed review of tunnel alignment and geology.
- Recommendations on cutter head inspections procedures in the expected various ground conditions (soil and rock) under high water table in permeable and impermeable excavation. Optimization of inspection procedure which might include preventive drainage, and ground treatments.
- Estimation of cutter disk consumption based on expected geology and TBM performance.
- Specifications for TBM selection to cope with expected geological conditions.
- Review of the work construction scheme and planning as prepared by STEC, delivering comments and recommendations.

General information

Location: Singapore

Start date: 2011

End date: 2012

Client : STEC

Technical information

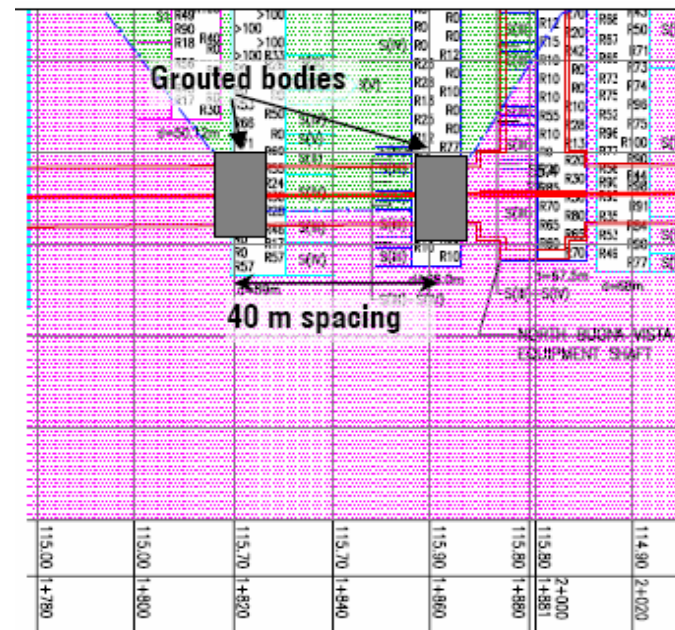
Excavation: TBM (EPB)

Lining: Precast segments

Length: 4,1 km

Excavation diameter: 6,88 m

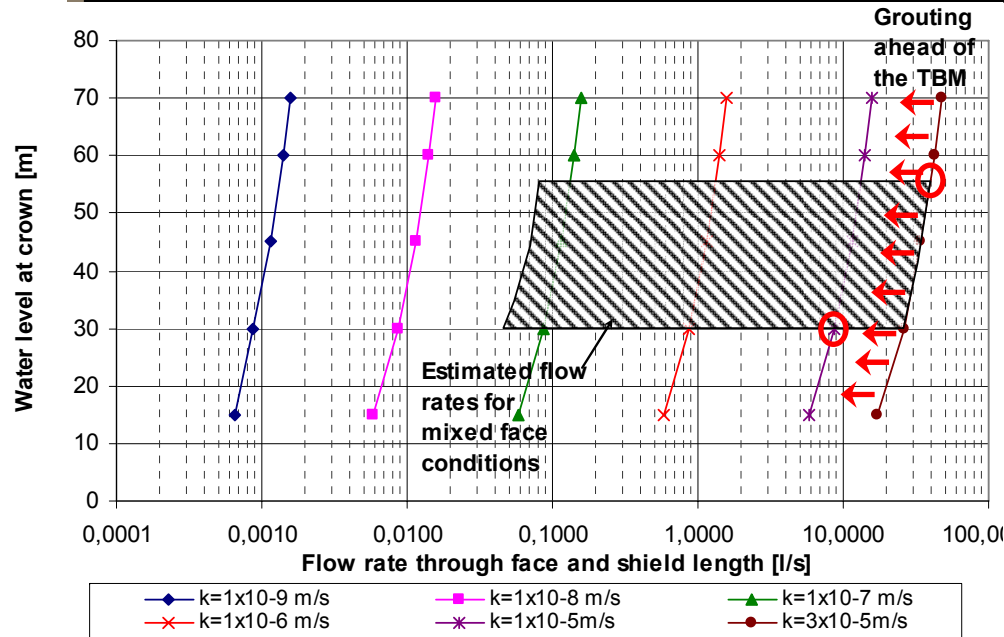
Ground cover: 60 m



Grouted bodies proposed for CHL in mixed face conditions

TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina



Description

Contract 2 of the North-South transmission cable tunnel comprises the construction of a total of 5350 m of tunnel as well as three off-line shafts. It is foreseen that the tunnel will be excavated with two (2) TBMs which must be capable of applying pressure to the tunnel face. The tunnel will be lined with a 300 mm thick segmental lining with 6.0 m internal diameter and 6.6 m external diameter. The tunnel will be bored in the weathered residual soil and fresh rock of the highly abrasive Bukit Timah Granite.

Scope of works

- Detailed review of tunnel alignment and geology.
- Recommendations on cutter head inspections procedures in the expected various ground conditions (soil and rock) under high water table in permeable and impermeable excavation. Optimization of inspection procedure which might include preventive drainage, and ground treatments.
- Estimation of cutter disk consumption based on expected geology and TBM performance.
- Specifications for TBM selection to cope with expected geological conditions.
- Review of the work construction scheme and planning as prepared by STEC, delivering comments and recommendations.

General information

Location: Singapore

Start date: 2011

End date: 2012

Client : STEC

Technical information

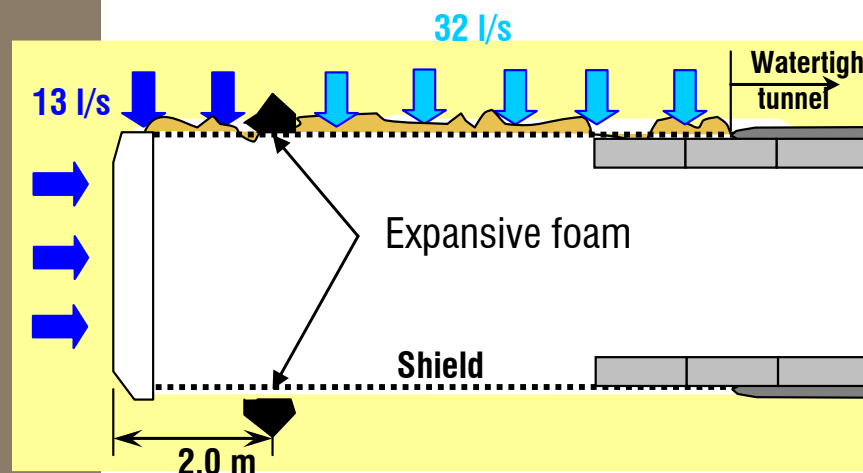
Excavation: TBM (EPB)

Lining: Precast segments

Length: 4,1 km

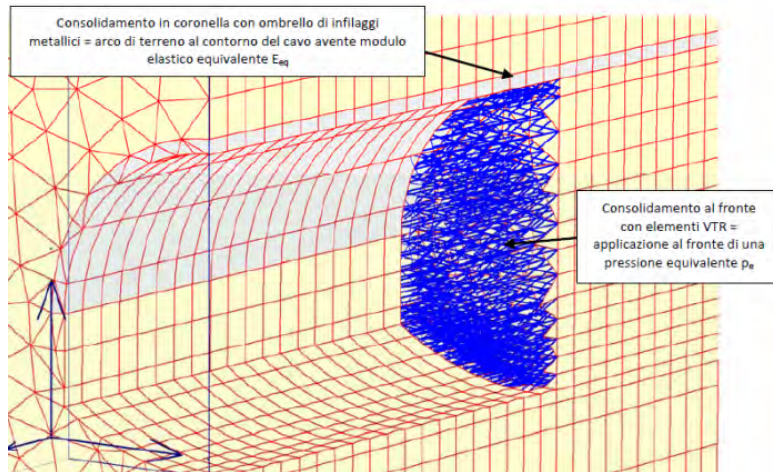
Excavation diameter: 6,88 m

Ground cover: 55 m



TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina



General information

Location: Tunis, Tunisia

Start date: 2011

End date: Ongoing

Client : D.A.M. S.p.a.

(Ravenna – Italy)

Technical information

Excavation: Mechanical, Adeco-RS method

Lining: Shotcrete, bolts, final cast in situ concrete lining

Length: 274m

Excavation section: 100m²

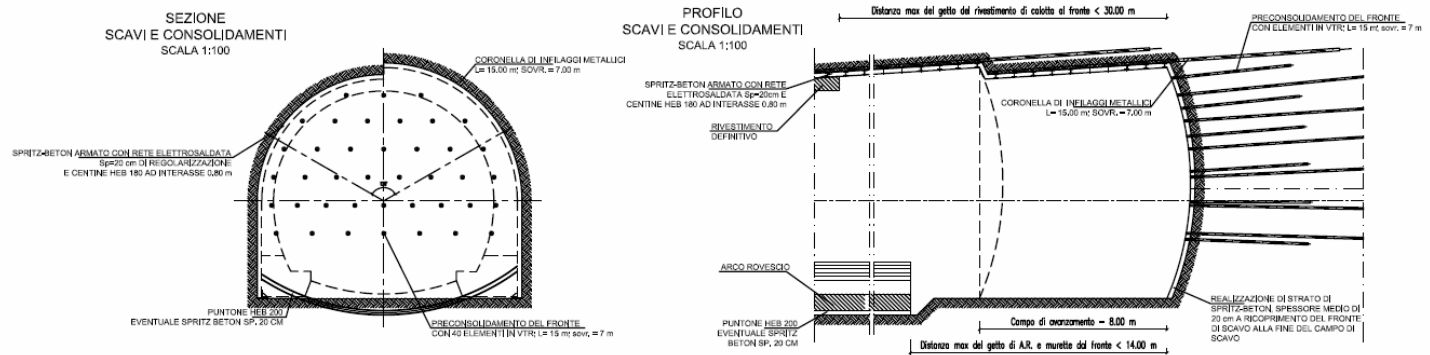
Ground cover: up to 24m

Description

In the framework of the “Réseau Ferroviaire Rapide (RFR)” Project, the construction of the Saida Mannoubia railway tunnel is foreseen in the highly urbanized metropolitan area of Tunis .

This large-diameter tunnel (excavation section 100m²) presents a 274m length and predominantly runs into poor quality yellow clays and medium to low quality limestones; additional issues are the low overburden and the sensitive buildings at surface presence.

The full face Adeco-RS excavation method has been foreseen; for this reason a fundamental role is played by the consolidation through fibreglass bolts of the soil core at tunnel face, which design has been based on accurate 3D FEM numerical computation.

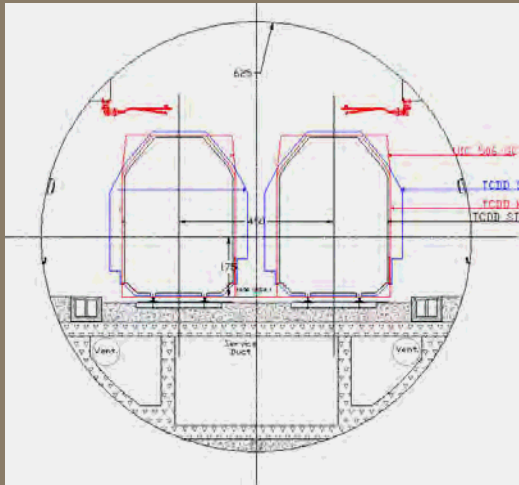


Scope of work

- Tunnel portals: detailed design
- Tunnel excavation method, temporary supports and final lining: detailed design
- Monitoring plan (tunnel convergence and surface settlements): detailed design

TC Responsible: Della Valle, Nicola

Technical staff: Di Gati, Leonardo / Savin, Eloi

**General information**

Location: Sakarya Province
(Turkey)

Start date: 2012

End date: 2012

Client : Gulermak

Technical information

Excavation: EPB

Lining: Precast segments

Length: 7,5 km

Excavation diameter: 12,5 m

Ground cover: 11,5 - 466 m

Description

Dogançay tunnel is the first tunnel encountered past Sapanca station along the Sapanca – Geyve line, forming part of the “TCDD Istanbul-Ankara High Speed Railway Project”. The tunnel alignment is 7472.8m long.

The tunnel shows an upwards slope equal to + 1.6% from the West portal up to the highest point of the alignment and beyond this point it goes head downwards with -0.9% grade. Dogançay tunnel crosses a relief whose highest peak reaches 560m AMSL, being the maximum overburden about 466m.

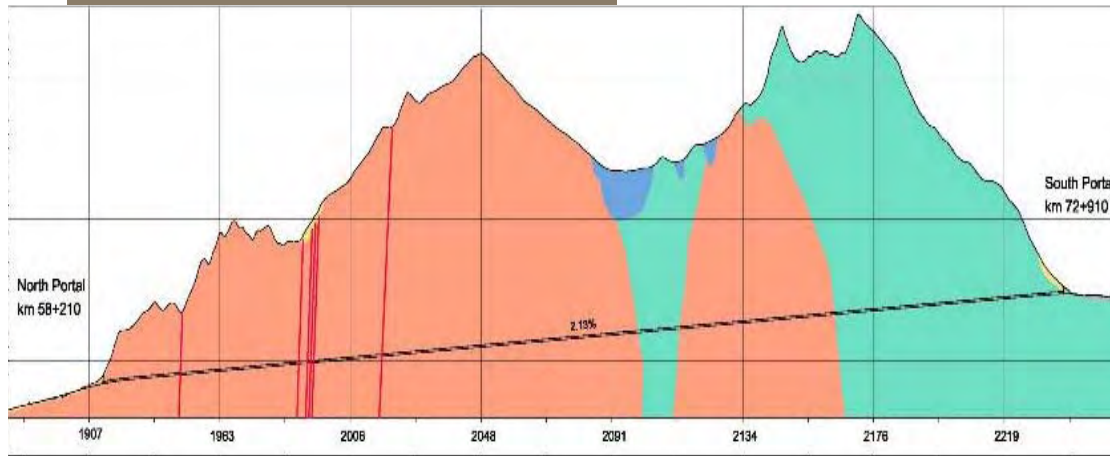
The tunnel accommodates a UIC GC cinematic gauge for a double track railway line with a train design speed of 250 km/h.

**Scope of work**

- Study of the available documents and geological conditions
- Definition of tunnel cross section: geometric and aerodynamic verifications
- Evacuation routes analysis
- Geometrical design of the segmental lining
- Selection of the most appropriate TBM system (EPB, HR or Slurry Shield)
- Definition of different construction sequences and work scheduling

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Savin, Eloi / Montobbio, Daniel / Bech, Sara



General information

Location: Iksidere (Turkey)

Start date: 2012

End date: 2012

Client : Gulermak

Technical information

Excavation: Open TBM

Lining: Cast in place lining

Length: 14,7 km

Excavation diameter: 12,74 m

Ground cover: 33-1043 m

Scope of work

- Study of the available documents and geological conditions
- Definition of tunnel dimensions according to Road Standards
- Geometrical design of the segmental lining
- Excavation method analysis (Open TBM vs Double Shield)
- Tunnel ventilation and shafts study

TC Responsible: Della Valle, Nicola

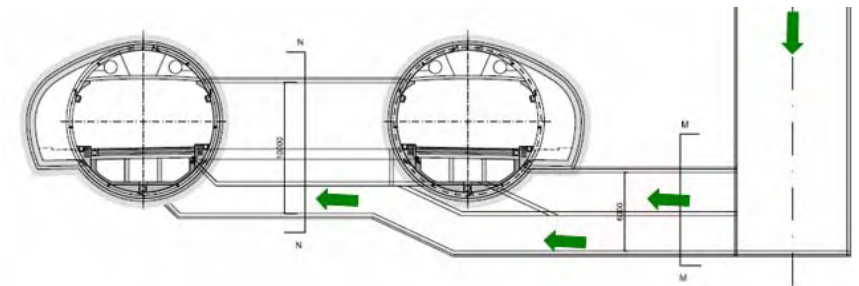
Technical staff: Salas, Regina / Savin, Eloi / Montobbio, Daniel / Bech, Sara

Description

The Oviti tunnel is projected as part of the new Rize – Erzurum Highway in Turkey within the Iksidere – Ispir stretch. The construction of the tunnel will significantly benefit the region because the existing road reaches 2600 m of altitude becoming dangerous and inaccessible due to snowfall during winter months.

The tunnel runs through the Mount Oviti with 14700 of length and at a constant slope of +2.13 % from north to south. The bidirectional highway is designed as a twin tunnel with two lanes, one tube for each traffic direction.

Tunnel ventilation is based on a transverse system that enables the insufflation of fresh air from the lower duct and the extraction of dirty air and fumes from the upper duct. Ventilation shafts construction is also foreseen at mid tunnel using the raise boring method.





General information

Location: Thessaloniki
(Greece)

Start date: 2012

End date: 2012

Client : Ghella

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 4.7 km

Excavation diameter: 6.14 m

Ground cover: 9-25 m

Scope of work

- Revision of the technical specifications for the tender design
- Geotechnical appraisal and segmental lining design.
- Tunnel monitoring plan, settlement analysis and buildings risk assessment.
- Excavation stability analysis and ground treatments.
- Stations crossing methodologies definition.
- TBM technical specifications and Risk Analysis.

TC Responsible: Della Valle, Nicola

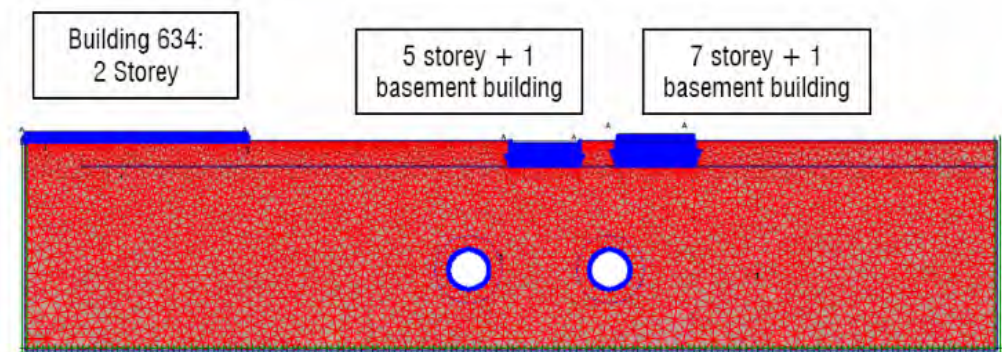
Technical staff: Salas, Regina / Montobbio, Daniel / Babbucci, Silvia / Plasencia, Victoria / Savin, Eloi / Bech, Sara

Description

Kalamaria Extension project consists on the excavation of a 4.7km long metro line and the construction of five new underground stations (Nomarchia, Kalamaria, Aretsou, Nea Krini and Micra). The metro line will be built up by two single track tunnels.

Each tunnel has an inner diameter of 5.3m and a permanent segmental lining 0.3m thick. An excavation diameter of approximately 6.14m has been foreseen.

The Metro Extension runs underneath Kalamaria and while the track 1 tunnel will be mainly excavated below streets along the alignment, the track 2 tunnel passes underneath several buildings.





Description

The Harel tunnels will be part of the Highway No. 1 (Jerusalem to Tel Aviv road) and will run beneath the Harel interchange near Castel and Mevaseret Zion. Each tunnel will be designed with three lanes and wide shoulders.

The tunnels are approximately 800m long and the project includes the excavation of three cross passages and six emergency lay bys.

General information

Location: Castel (Israel)

Start date: 2012

End date: 2012

Client : MINRAV

Technical information

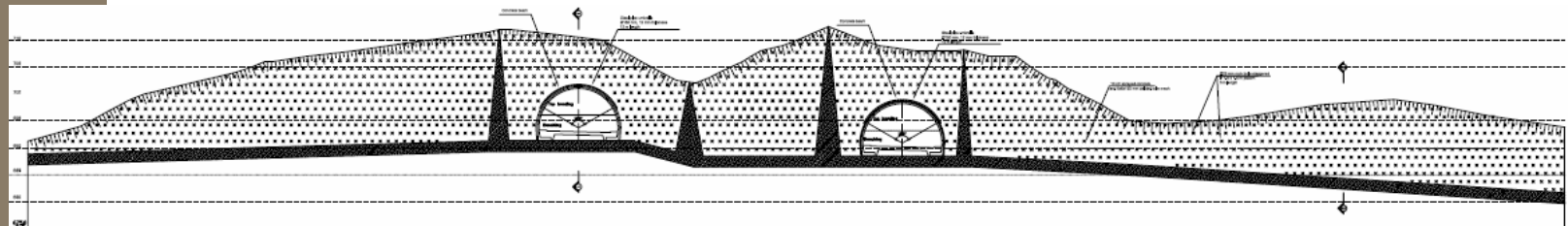
Excavation: Conventional method (NATM)

Lining: Cast-in-situ final lining

Length: 2 x 0.8 km

Excavation diameter: 15.38 m

Ground cover: up to 40 m



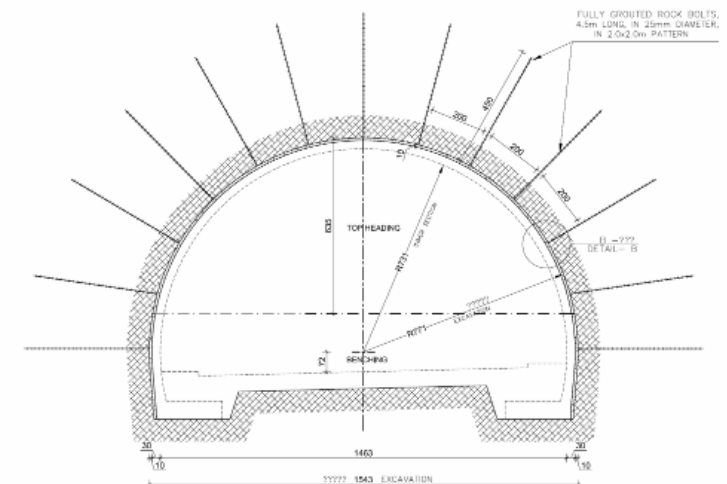
MASSIVE TO JOINTED ROCK, FAIR ROCK.
Scale 1:100

Scope of work

- Optimisation of the tunnel support according to the rock class.
- Portal slopes definition in substitution of portal piles and portal slopes stability verification.
- Estimation of Bill of Quantities (BOQ).

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Bech, Sara



**General information**

Location: Istanbul (Turkey)

Start date: 2012

End date: Ongoing

Client : Prota

Technical information

Excavation: NATM and TBM

Lining: Conventional support,
final lining and precast segments

Length: 2 x 17km

Excavation diameter: 6.57–15.6m

Ground cover: from 3 to 80m

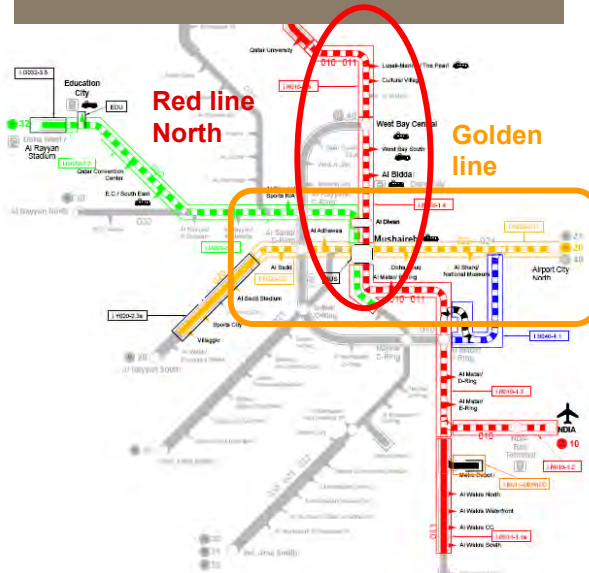
Description

“Uskudar – Umraniye - Cekmekoy Metro Line” is a project of public transportation railway system connecting the municipality of Uskudar to the districts of Umraniye and Cekmekoy located in the eastern outskirts of Istanbul. The project includes the excavation of the main line 17.0km long by a twin single track tunnel, a total of 16 underground stations, depot site connection tunnel and depot site.

The tunnel alignment starts at Uskudar station, located in the proximity of Bosphorus. From the coast the tunnel develops toward East, running below a hilly relief, which corresponds to the maximum overburden (80.0m). The minimum overburden is limited to only 3m near Uskudar area, where ground treatments shall be likely required. The general overburden stays between 20-40m.

**TC Responsible:** Della Valle, Nicola**Technical staff:** Babbucci, Silvia / Sáenz de Santa María, Iñaki / Savin, Eloi / Salas, Regina / Bech, Sara**Scope of work**

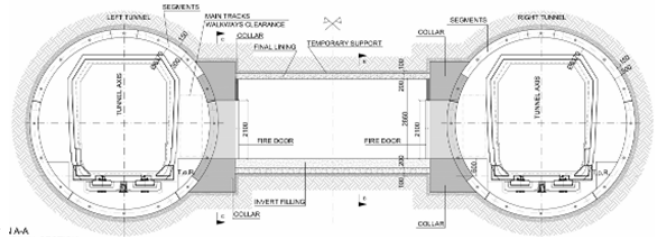
- Geotechnical Baseline Report (GBR).
- TBM lining and NATM support and final lining detailed design.
- Excavation methods and ground treatments assessment.



Description

The Red Line North and Golden lines are part of the underground metro lines future development running beneath semi urban and urban areas in Doha. These lines will be excavated as a twin tunnel mainly excavated using TBM.

The Red Line North has a length of 13.0km, running from the Northern platform of Mushaireb Station to Lusail Marina / The Pearl Station located next to the artificial canals zone. The Golden Line is approximately 12.0km in length and includes a stretch of 2.8km of the Blue Line.



General information

Location: Doha (Qatar)

Start date: 2012

End date: 2012

Client : Dogus-Makyol-
Ssangyong-Redco JV

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 13+13 km

Excavation diameter: 7.07 m

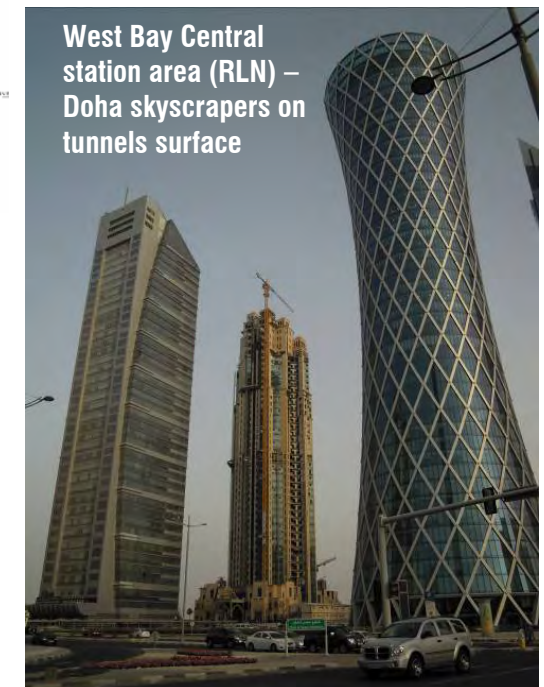
Ground cover: 8 - 37 m

Scope of work

- Technical assistance to JV in relation to the tunnel works for preparing a competitive basic tunnel design for the tender package
- Geotechnical Baseline report (GBR)
- Segmental lining and cross passages collar design.
- Tunnel monitoring plan, settlement analysis and buildings risk assessment.
- Excavation stability analysis and ground treatments.
- Stations crossing methodologies definition.
- TBM technical specifications and Risk Analysis.

TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina / Montobbio, Daniel / Babbucci, Silvia / Plasencia, Victoria / Bech, Sara



West Bay Central
station area (RLN) –
Doha skyscrapers on
tunnels surface



General information

Location: San Fernando
(Chile)

Start date: 2012

End date: 2012

Client : Hidroelectrica El Paso

Technical information

Excavation: Drill & Blast

Lining: Conventional support

Length: 4.5 km

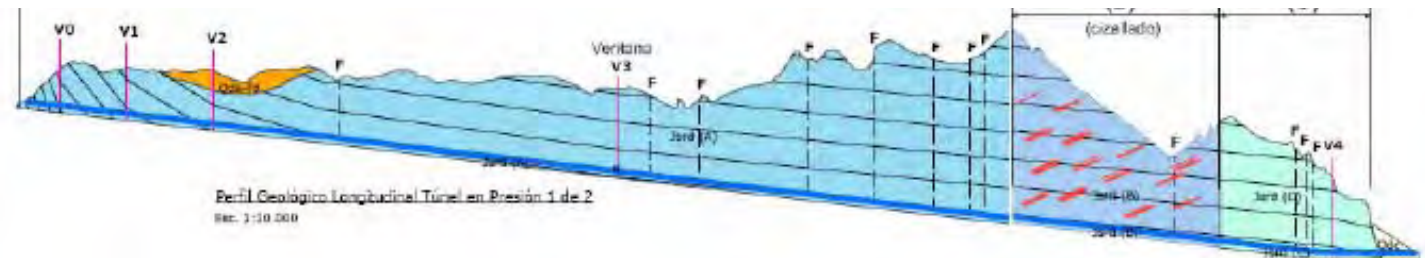
Excavation diameter: 4.10 m

Ground cover: up to 650 m

Description

The hydroelectric project El Paso consists of an construction of a headrace tunnel with a length of about 4.5 km by drilling and blasting (D&B) method.

The tunnel has a profile with a slope between 11% and 11.14% and it considers two sections. The Tunnel Section 1 is defined by a horseshoe section with 4.1m diameter and 4.1m in height with a flat invert. The Tunnel Section 2 is defined with half a point geometry, with a diameter of 4.0m and a height of 4.7m and flat invert. The inner tunnel suffers pressures in arange from 2 to 50 bars.



Scope of work

- Collection and analysis of geological-geomechanical documents.
- Verification of the support systems in function of the rock quality.
- Assessment on final lining definition.

TC Responsible: Della Valle, Nicola

Technical staff: Montobbio, Daniel





Description

“Uskudar – Umraniye – Cekmekoy Metro Line” is a project of public transportation railway system connecting the municipality of Uskudar to the districts of Umraniye and Cekmekoy located in the eastern outskirts of Istanbul. The project includes the excavation of the main line 17.0km long by a twin single track tunnel, a total of 16 underground stations, depot site connection tunnel and depot site.

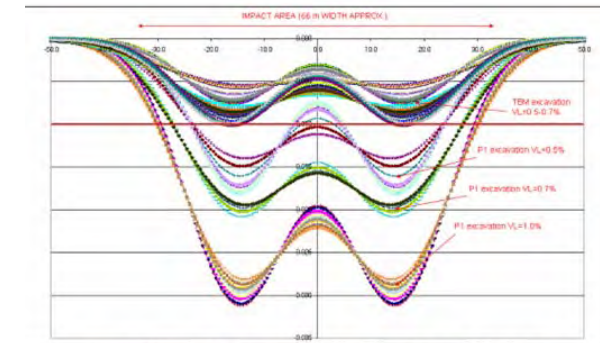


Figure 8 Computerized settlements trough from SDR to Rulerin SDR stations

General information

Location: Istanbul (Turkey)

Start date: 2012

End date: Ongoing

Client : Dogus

Technical information

Excavation: NATM and TBM

Lining: Conventional support, final lining and precast segments

Length: 2 x 17km

Excavation diameter: 6.57–15.6m

Ground cover: from 3 to 80m

The tunnel alignment starts at Uskudar station, located in the proximity of Bosphorus. From the coast the tunnel develops toward East, running below a hilly relief, which corresponds to the maximum overburden (80.0m). The minimum overburden is limited to only 3m near Uskudar area, where ground treatments shall be likely required. The general overburden stays between 20-40m.

TC Responsible: Della Valle, Nicola

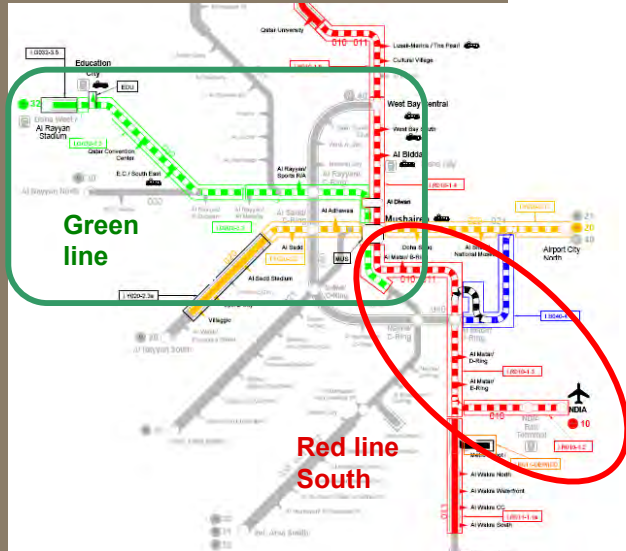
Technical staff: Babbucci, Silvia / Sáenz de Santa María, Iñaki / Savin, Eloi / Bech, Sara



Typical concrete buildings in Uskudar

Scope of work

- EPB working pressure recommendations.
- Settlement analysis and building risk assessment.



Description

The Green Line and the Red Line South are part of the “Doha “Priority Metro Network”. The Green and Red South Line will be constructed as a twin tunnel excavated using TBM and the stations and switchbox will be executed using the cut and cover method. The lines run beneath semi urban and urban areas in Doha.

The Green line is approximately 14.8 km long and the Red Line South total underground length is approximately 12 km. Both lines starts from Mushaireb station and while the GL goes westwards to the Education City station, the RLS runs towards the south ending at the NDIA station.

General information

Location: Doha (Qatar)

Start date: 2012

End date: 2012

Client : STEC

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 17+12 km

Excavation diameter: 7.07 m

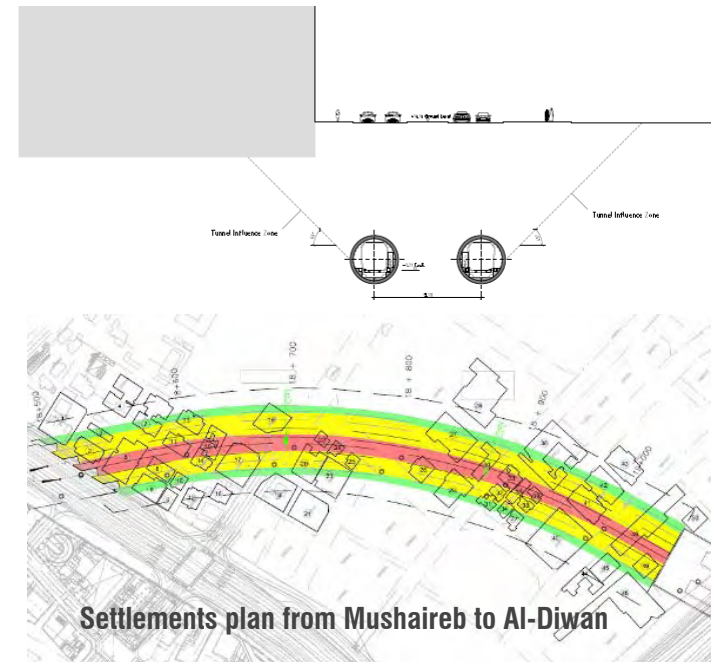
Ground cover: 7 - 38 m

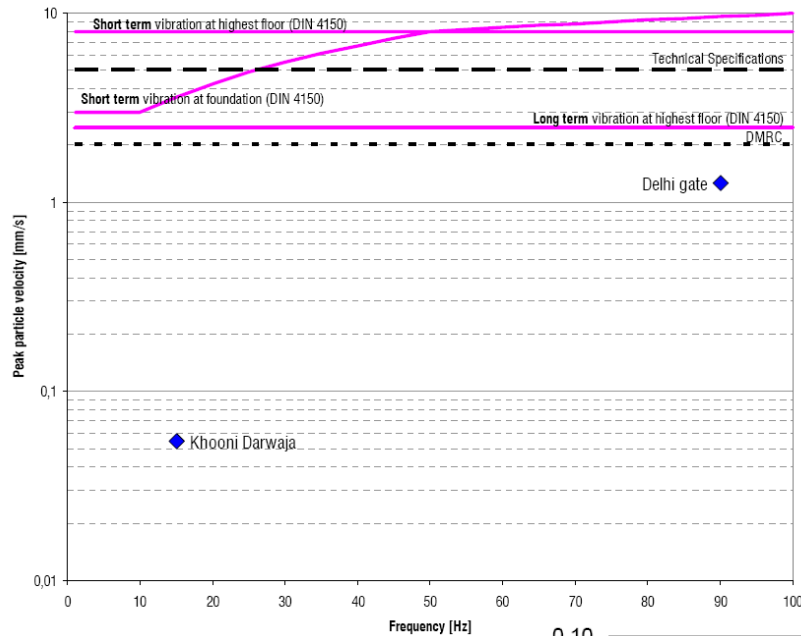
Scope of work

- Technical assistance to JV in relation to the tunnel works for preparing a competitive basic tunnel design for the tender package
- Geotechnical Baseline report (GBR)
- Segmental lining and cross passages collar design.
- Tunnel monitoring plan, settlement analysis and buildings risk assessment.
- Excavation stability analysis and ground treatments.
- Stations crossing methodologies definition.
- Geotechnical Risk Analysis.

TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina / Montobbio, Daniel / Babbucci, Silvia / Plasencia, Victoria / Bech, Sara





General information

Location: India

Start date: 2012

End date: 2012

Client : L&T SUCG JV

Technical information

Excavation: TBM (EPB)

Lining: Precast segments

Length: 4,1 km

Excavation diameter: 6,88 m

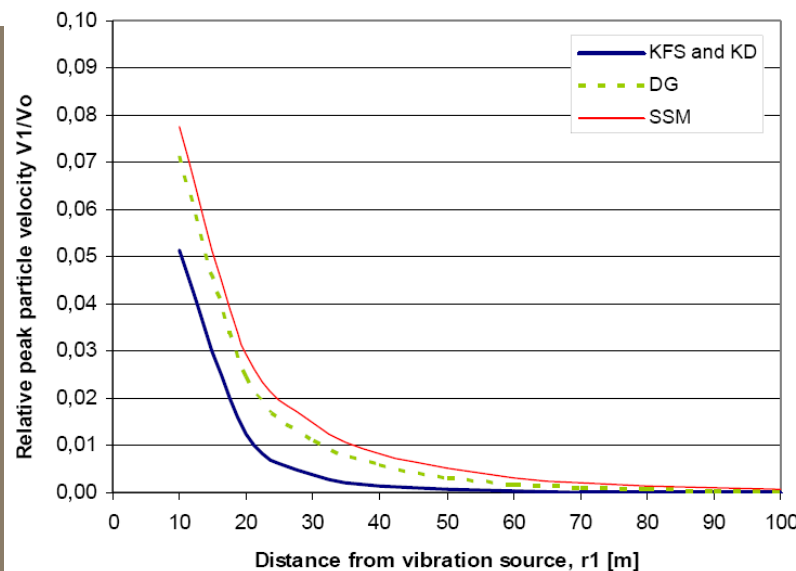
Ground cover: 24 m

Description

Contract CC-05 of Delhi Metro phase III covers the tunnel line between Mandi house and Jama Masjid stations. The project consists in two 5.70 internal diameter twin tunnels which run under low overburdens of 10 to 24 meters. The tunnels will pass close to four archeological Monuments: Delhi gate, Kotla Firoz Shah, Khooni Darwaja and Sahi Sunehri Masjid. Due to the importance and historical value of the structures the Contractor JV has engaged Tunnelconsult to estimate the possible effects of the TBM induced vibrations on the structures as well as determine the preventive measures if necessary.

Scope of works

- Estimation of possible effects of TBM induced vibrations on each of the structures through the derivation of site-specific vibration prediction equations for each monument.
- Recommendations on preventive or mitigation measures to prevent damages.
- Drafting of a monument protection plan including a vibration monitoring plan.
- Review of settlement calculations performed by a third party for Khooni Darwaza and Delhi gate and execution of a detailed settlement analysis to estimate the expected settlements magnitude due to tunnel boring to assess the potential effects and compare the results with those provided by the JV.



TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina



Description

The “Central Subway Project” consists of the second phase of the “Third Street Light Rail Program” for the improvement of the public transport network in San Francisco. The project comprises the stretch from the Washington Square to the intersection between Fourth Street and Brannan Street.

The metro line is located in a very dense urban area of Northern Area of San Francisco, and both tunnels mainly run beneath three streets: Columbus Avenue, Stockton Street and 4th Street. The project consists of 2,410 feet (734.6 m) of surface track and approximately 8,232 route feet (2864.7 m) of underground in a single track tunnels or cut and cover box.

General information

Location: San Francisco (US)

Start date: 2012

End date: 2012

Client : Impregilo

Technical information

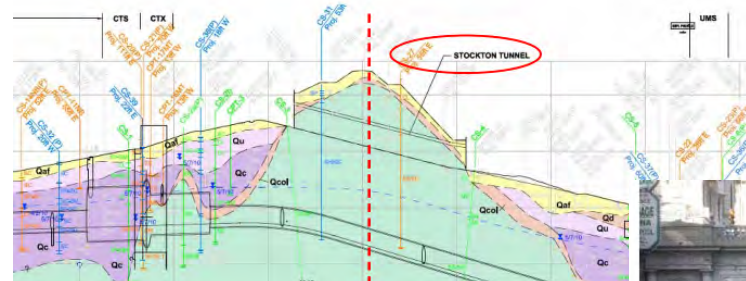
Excavation: TBM (EPB shield)

Lining: Precast segments

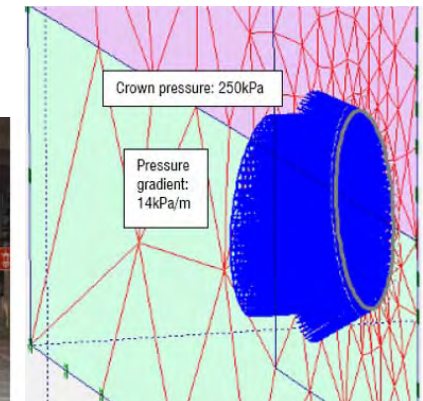
Length: 2.86 km

Excavation diameter: 6.24 m

Ground cover: 6-48 m



Stockton tunnel

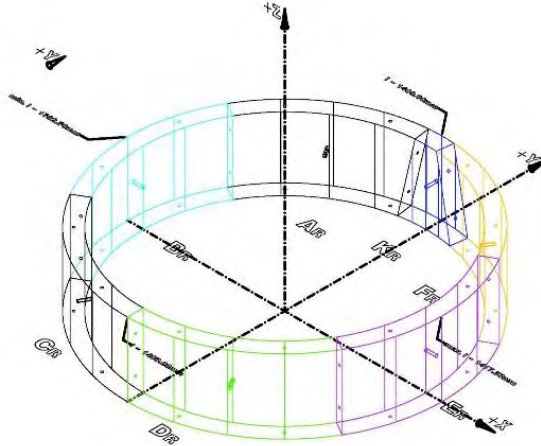


Scope of work

- EPB pressure analysis.
- Settlements analysis and buildings assessment.

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Savin, Eloi / Bech, Sara



Description

The project consists on the execution of 9048 m long metro line of the Lyublinsko-Dmitrovskaya metro line from Mar'ina Roscha until Seligerskaya station at the Moscow Metro Network. Two single track tunnels with an average spacing of 19m between axis will be constructed.

The existing ground along the alignment is basically composed by plastic clay with tight consistency on upper levels corresponding to fluvio-glacial Dniepper deposits and limestone with clay on lower levels

General information

Location: Moscow (Russia)

Start date: 2012

End date: 2013

Client : Engproject

Technical information

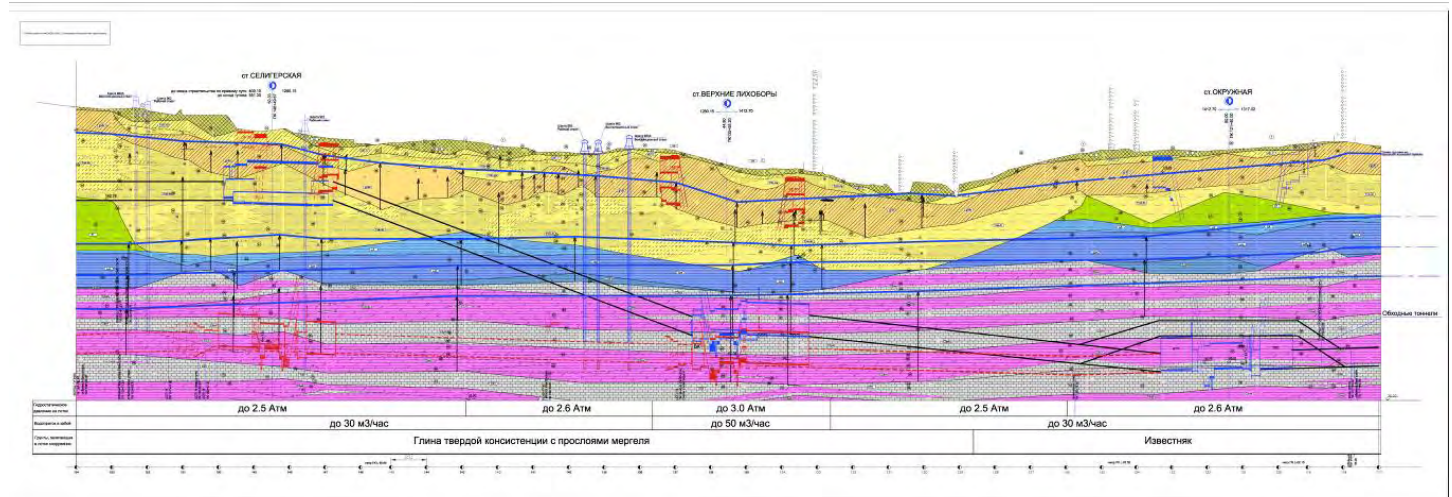
Excavation: TBM

Lining: Precast segments

Length: 9.05 km

Excavation diameter: 6.24 m

Ground cover: 17-72 m



TC Responsible: Della Valle, Nicola

Technical staff: Oliver, Ricard

Scope of work

- Main tunnel precast segments design



General information

Location: Moscow (Russia)

Start date: 2012

End date: 2013

Client : Engproject

Technical information

Excavation: TBM

Lining: Shaft precast segments

Length: 1.15 km

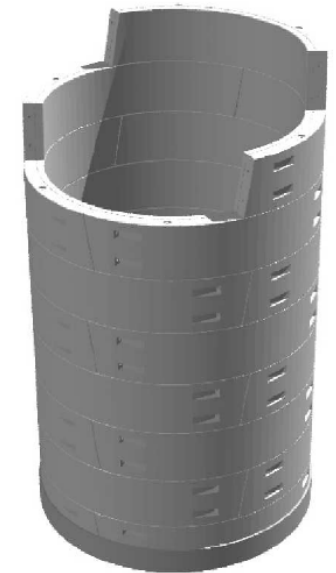
Excavation diameter: 6.7 m

Shaft depth: 47-84 m

Description

The project consists on the execution of 18 vertical shafts within the Lyublinsko-Dmitrovskaya metro line from Mar'ina Roscha to Seligerskaya stations. The existing ground along the alignment is basically composed by plastic clay with tight consistency on upper levels corresponding to fluvio-glacial Dniepper deposits and limestone with clay on lower levels.

The shafts will be excavated with a vertical shaft machine (VSM). The construction procedure is that while machine realizes the excavation, shaft ring sinks in the opening. All the operation is carried out under water, and it is likely that rings shall be pushed downward against soil friction.

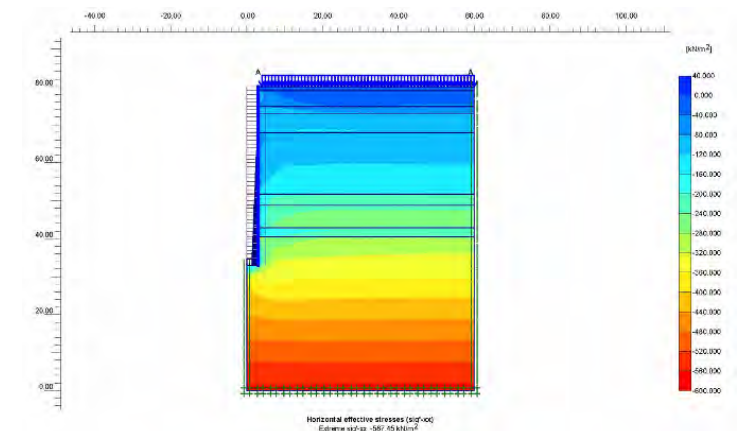


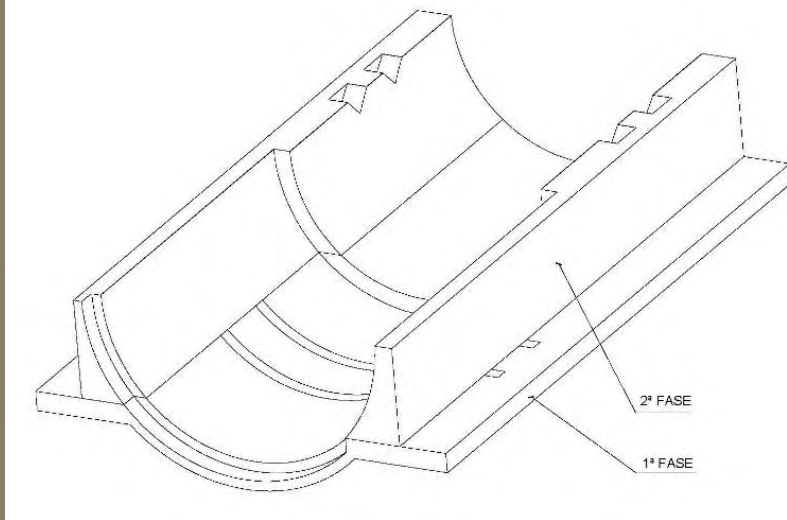
Scope of work

- Shafts precast segments design

TC Responsible: Della Valle, Nicola

Technical staff: Oliver, Ricard / Bech, Sara





General information

Location: Caltanissetta (Italy)

Start date: 2012

End date: Ongoing

Client : CMC Ravenna

Technical information

Excavation: TBM (EPB shield)

Lining: Precast segments

Length: 4.0 km

Excavation diameter: 15.08 m

Ground cover: 80-135 m

Scope of work

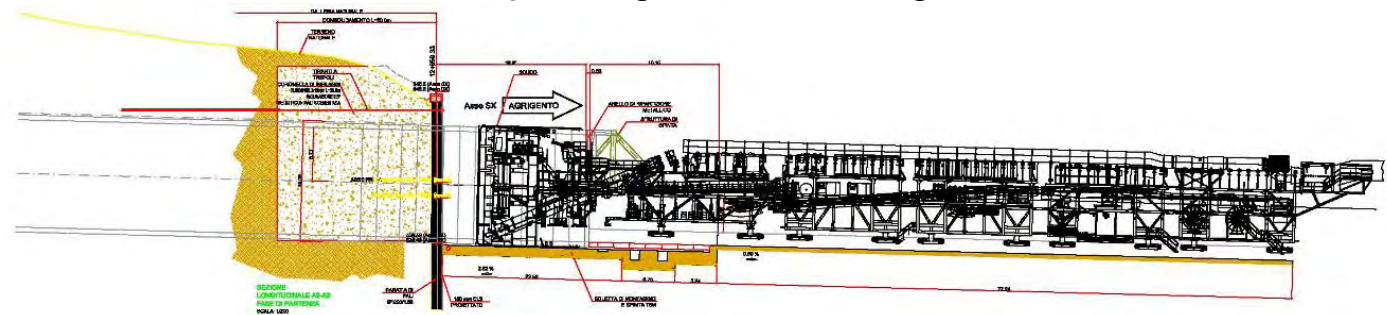
- Geometrical and Structural design of the tunnel portals
- Geometrical and Structural design of the base slab and thrust frame for TBM assembly and launching

Description

The Caltanissetta double bored road tunnel is one of the main works of the route Agrigento – Caltanissetta - A19 in Sicily. It has a circular section with a diameter of excavation of approximately 15,08m. The two tunnels are spaced between 35 and 80m and extend for a length of about 4 km, for a good part of which below the city of Caltanissetta.

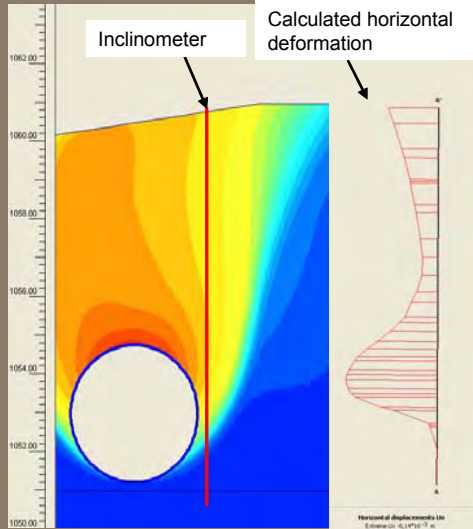
The overburden for almost the whole tunnels ranges from 80 to 135 meters, except in the portals where the overburden is limited to a few tens of meters.

This new motorway connects Porto Empedocle to the Caltanissetta junction and aims to improve road connections to south Sicily by expanding the current regional road network .



TC Responsible: Della Valle, Nicola

Technical staff: Oliver, Ricard / Montobbio, Daniel / Savi, Eloi



General information

Location: San José (Costa Rica)

Start date: 2012

End date: 2013

Client : Ghella

Technical information

Excavation: TBM

Lining: Precast segments with mixed reinforcement (rebars + steel fibres)

Length: 1.8 km

Excavation diameter: 3.5 m

Ground cover: 7-40 m

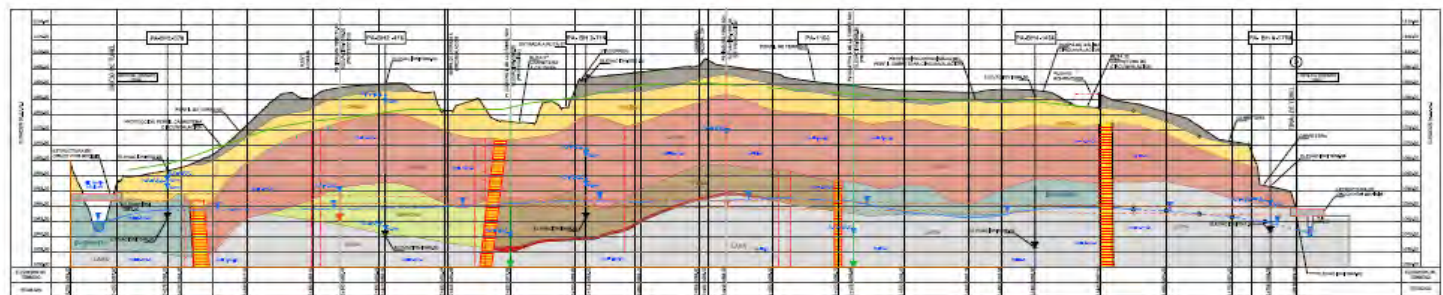
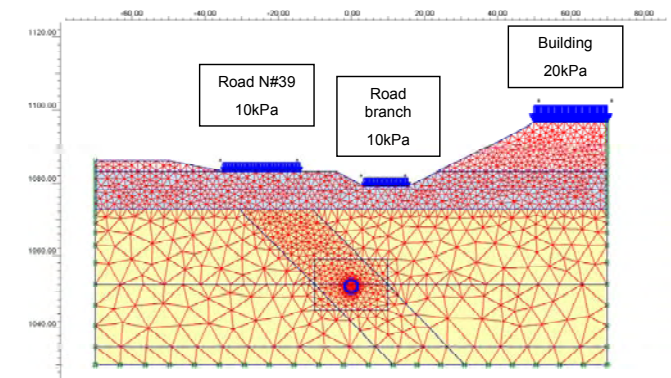
Description

The “Trasvase” tunnel in San José will be constructed between the Tiribía and María Aguilar river catchments for the sewerage transportation (4.2 m³/s flow). The tunnel will be mainly excavated underneath public roads between the Aguilar and Torres rivers, although it will also run underneath some buildings at the end area, before the Bajo los Ledesma.

The average overburden ranges from 30 to 40 m along the alignment, but in the portals the overburden is reduced, being just 7m at the Torres river end portal.

Scope of work

- Technical assistance in relation to the tunnel works for preparing a competitive basic tunnel design for the tender package.
- Segmental lining design.
- Monitoring and control.
- EPB pressure study.

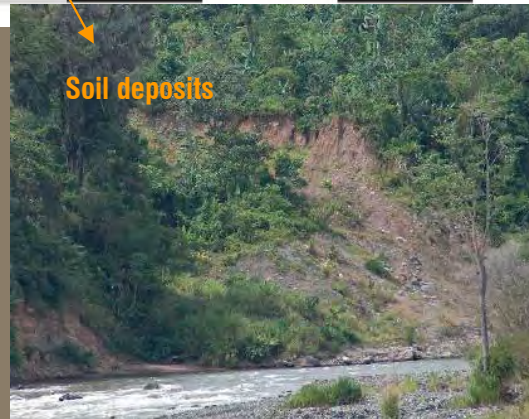


TC Responsible: Della Valle, Nicola

Technical staff: Salas, Regina / Molina, Marc / Bech, Sara



Soil deposits

**General information**

Location: Costa Rica

Start date: 2012

End date: 2013

Client : Gas Natural Fenosa

Technical information

Excavation: TBM

Lining: Precast segments

Length: 3.6 km

Excavation diameter: 7.9 m

Ground cover: 35-180 m

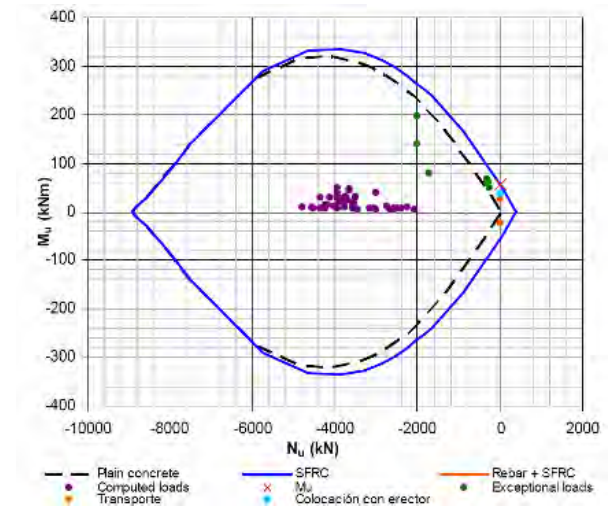
Description

The PH Torito project is located in the Reventazón river catchment, downstream the Angostura hydroelectric. The installed power will be 50 MW and the average annual production 305 GWh. The tunnel has a length of 3.5 km and will be excavated with an EPB (Earth Pressure Balance machine). The overburden ranges 35 to 180 m.

The geology of the tunnel mainly consists on calcarenites, conglomerates and pelites, and a short stretch of soil deposits. Nine faults are identified along the tunnel alignment.

Scope of work

- Technical assistance to the segmental lining design revision.
- Segments reinforcement proposal: option 1 - only steel fibres reinforced concrete and option 2- mixed reinforcement (rebars + steel fibres)

TC Responsible: Della Valle, Nicola**Technical staff:** Bech, Sara / Montobbio, Daniel

**Bending – axial diagram for the
SFRC verification in ULS**



Description

Steel Fibres Reinforced Concrete (SFRC) is a competitive design alternative in precast segments as it would partly or totally substitute the conventional reinforcement to allow for time reduction in handling and placing of the curved rebars in tunnel segments construction.

The Model Code 2010, which was approved in October 2011, and developed by the FIB (*Fédération Internationale du béton*) in order to set up the design bases for the fibre reinforced concrete, is the reference standard for the structural verification.

General information

Location: Singapore, Bangkok, Hong Kong, Copenhagen, Viroflay, Santa Lucia, Cefalù

Start date: 2008

End date: Ongoing

Client : Maccaferri

Technical information

Excavation: TBM

Lining: Precast segments

Scope of work

- Technical Assistance on the steel fibres feasibility.
- Steel fibres types and characteristics definition.
- Testing plan assessment.
- Tunnel alignment tramification on segments reinforcements types.



TC Responsible: Della Valle, Nicola

Technical staff: Bech, Sara



General information

Location: Chennai, India

Start date: 2013

End date: ongoing

Client: L&T – SUCG JV

Technical information

Excavation: TBM (EPB)

Lining: Precast segments

Length: 3.4 km twin tubes

Excavation diameter: 6.6 m

Ground cover: 14-18 m

Description

The first stage of Chennai Metro Rail Project includes the design and construction of two corridors, Corridor 1 (Washermanpet – Airport) and Corridor 2 (Chennai Central – St. Thomas Mount). Underground works have been divided into 5 packages.

As a part of Corridor 2, package UAA-04 starts from Egmore Station and moves west till Shennoy Nagar Station. It consists in 3.4km long twin tunnels that will be bored mainly in younger alluvium of sandy and clayey soil. Bedrock is encountered in some stretches of the tunnel alignment. It consists in both Archean charnockite and sedimentary formations, mainly shale and sandstone. Three Earth Pressure Balance (EPB) TBM will be used for the excavation of the tunnels. The TBMs will also install a segmental lining consisting of 5.8m i.d. rings and 275 mm thick segments.



Scope of work

- Re-interpretation and verification of existing geological profile based on all the available geotechnical information.
- Assessment and recommendations regarding cutting tools on the cutterhead.
- Recommendations on mixed face conditions excavation.

TC Responsible: Della Valle, Nicola

Technical staff: Babbucci, Silvia / Molina, Marc