



ITATUNNELLING  
AWARDS 2018



# Zarbalizadeh Shallow Tunnel Construction underneath the Operating Railways in Tehran, Iran

Presented by: Seyed Mahdi Pourhashemi  
*Project Manager*



## Key stakeholders:

- OWNER:
  - ❖ Tehran Municipality
  
- Consultants:
  - ❖ CVR Consulting Engineers
  - ❖ SCE Consulting Engineers
  
- Contractor:
  - ❖ Hera Co.



# THE PROJECT IN BREIF




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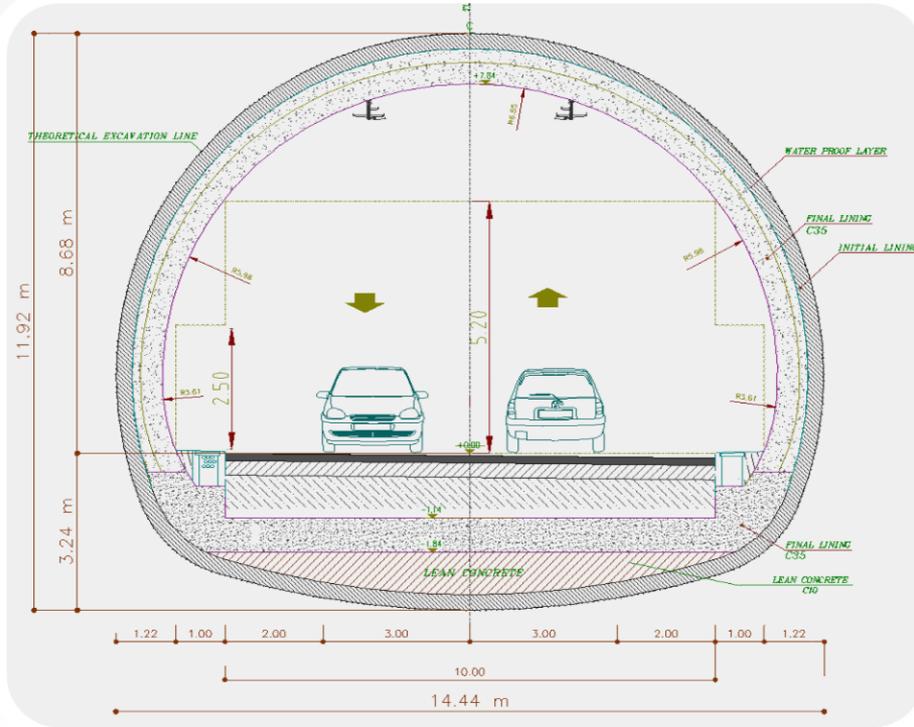

Zarbalizadeh underpass project is an urban tunnel with an average over-burden of about 3.5m. This tunnel consists of a multi-arc section and was excavated by the NATM method.

**PROJECT INFORMATION**

<b>Contract Value</b>	<b>4 million €</b>
<b>Construction Period</b>	<b>12 months</b>
<b>Length of Tunnel</b>	<b>105 m</b>
<b>Project excavation Vol.</b>	<b>32000 m3</b>
<b>Project Concrete Vol.</b>	<b>7600 m3</b>
<b>Overall Project length</b>	<b>550 m</b>
<b>Grouting Vol.</b>	<b>125000 lit.</b>
<b>Forepoling Length</b>	<b>4980 m</b>
<b>Tunnel Excavation width</b>	<b>14 m</b>
<b>Excavation height</b>	<b>11.9 m</b>



THE PROJECT IN BREIF



➤ Geometrical tunnel section



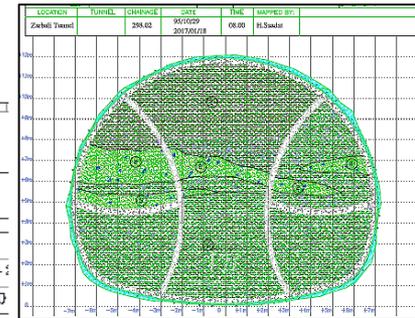
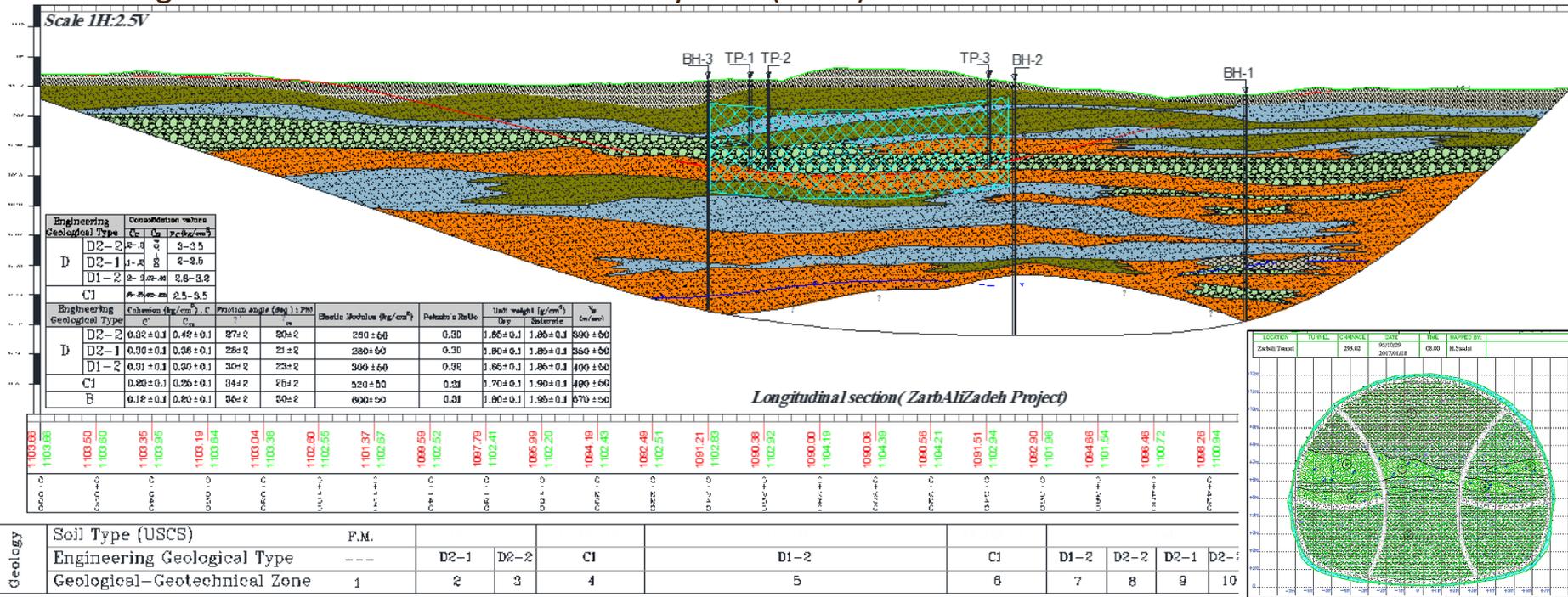
➤ View of the tunnel



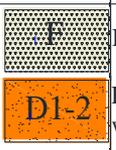
# Project ground conditions



Types of soil of the project area range from low plasticity silt (ML) to low plasticity clay & silt (CL-ML) according to the Unified Soil Classification System (USCS)

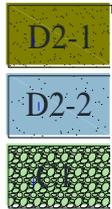


## Engineering Geological Legend



Fill Soil

D1-2 Hard to very hard/very sandy CLAY/SILT with gravel mixture



D2-1 Soft to hard/very sandy CLAY/SILT

D2-2 Hard to very hard/very sandy CLAY/SILT

Very silty/clayey SAND with gravel, and very sandy CLAY/SILT with gravel mixture



B Generally contains SAND with clay/silt and sandy GRAVEL with clay



## Project Ground Conditions

PROJECT  
OF THE YEAR INCL.  
RENOVATION  
- UP TO €50 M -



### ➤ Facing geotechnical problems

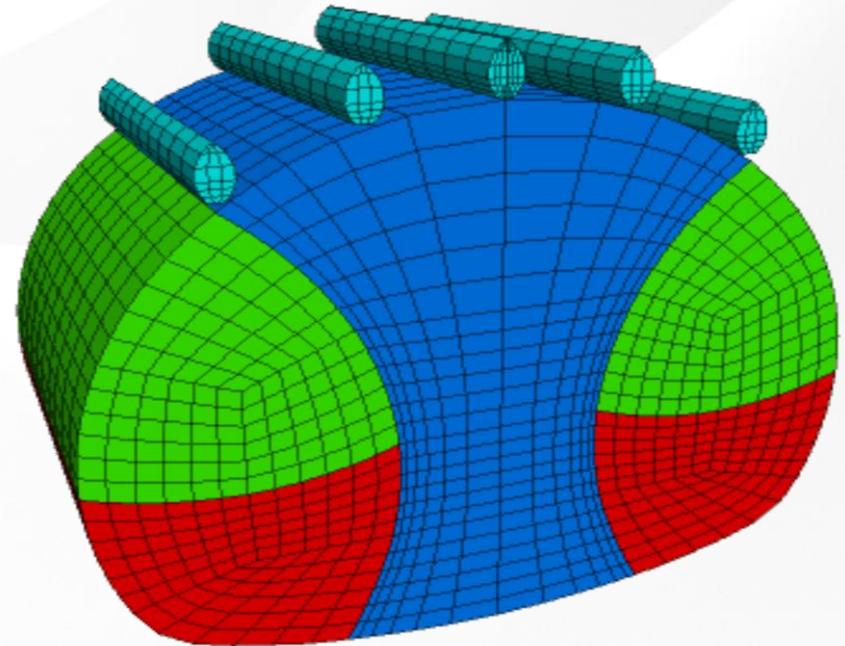
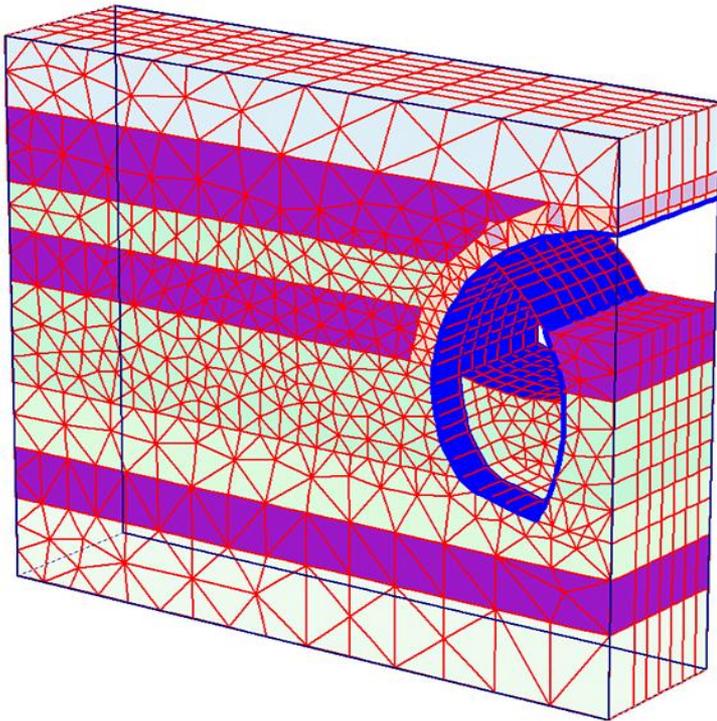
Existing deep disturbed & organic soil in the western ramp of the project.

### ➤ In-situ shear test



Analysis & Design  
of the tunnel

Numerical modeling was performed in two-dimensional and three-dimensional format using PLAXIS 2D & 3D software



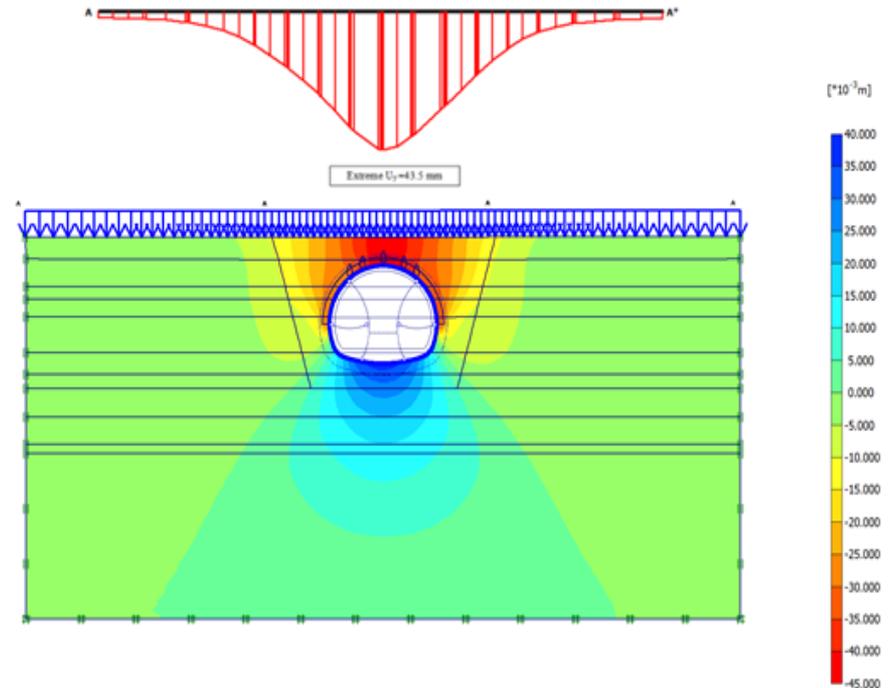
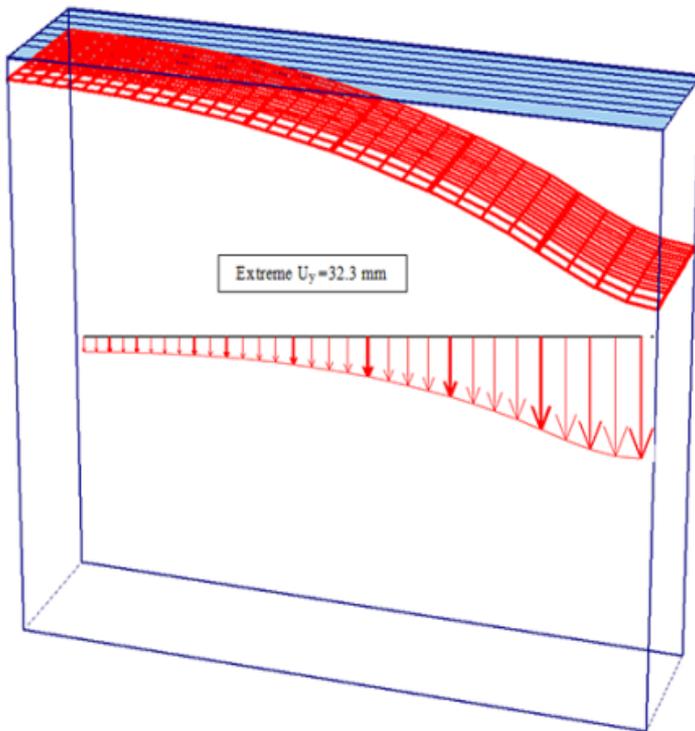
Stress & Displacement analysis of Zarbalizadeh Tunnel



## Analysis & Design of the tunnel

**PROJECT  
OF THE YEAR INCL.  
RENOVATION**  
- UP TO €50 M -

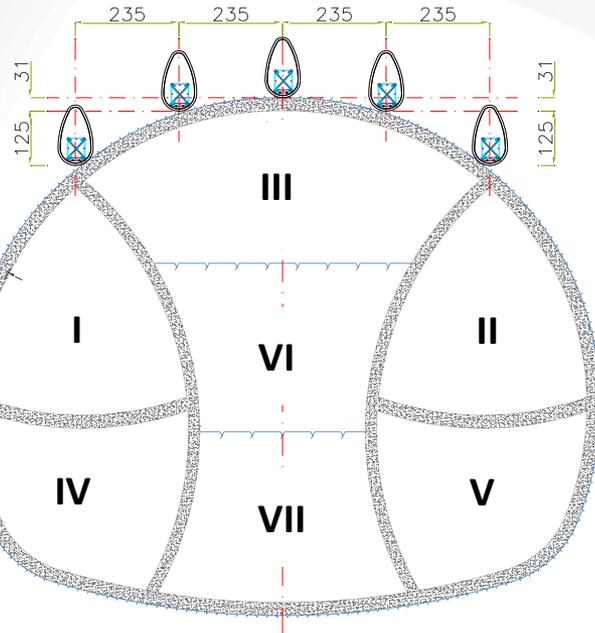
Displacement analysis was performed in two-dimensional and three-dimensional format using PLAXIS 2D & 3D software



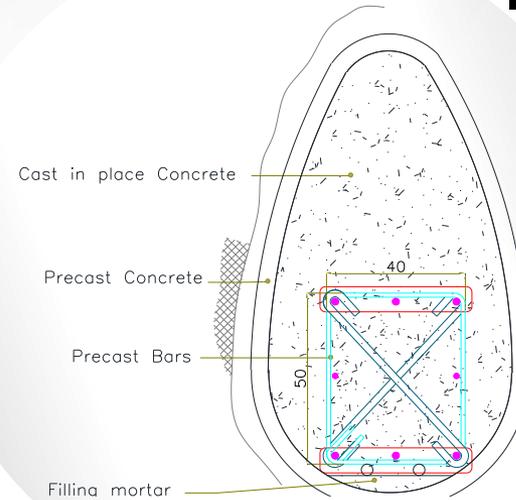
Displacement analysis of Zarbalizadeh tunnel



# Construction Stages



TUNNEL EXCAVATION & MICRO TUNNEL SECTIONS



Using a hybrid pre-consolidation system including the implementation of leading beams (Micro tunnel) and fore-poling



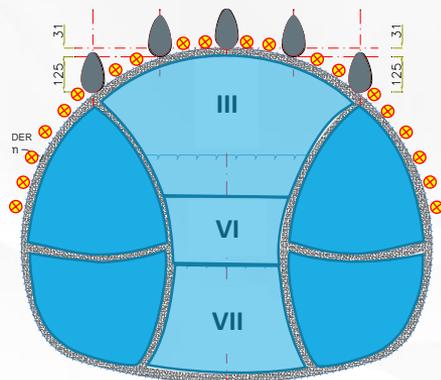


# Construction Stages



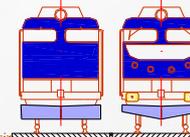
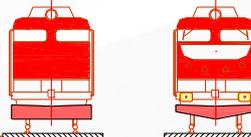
West Portal

East Portal



N-S RailWay

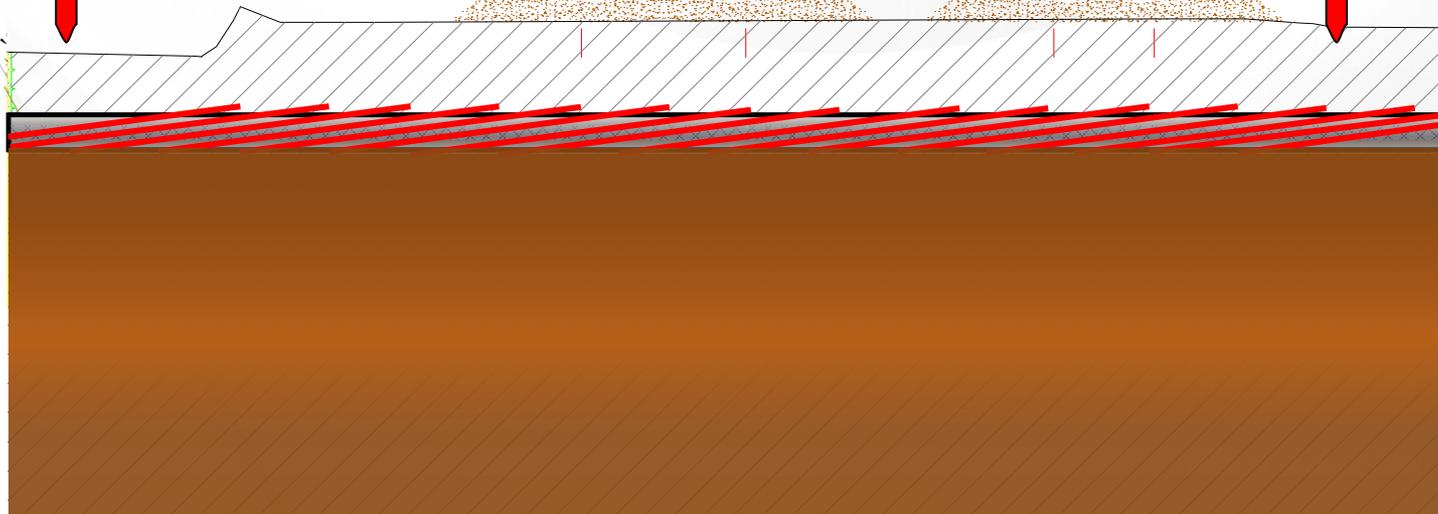
Metro L1



PORTAL SUPPORT

FOREPOLING PIPE  $\phi 0.76$   
L=6.00m

PORTAL SUPPORT





Some Construction stage pictures





## Project Limits

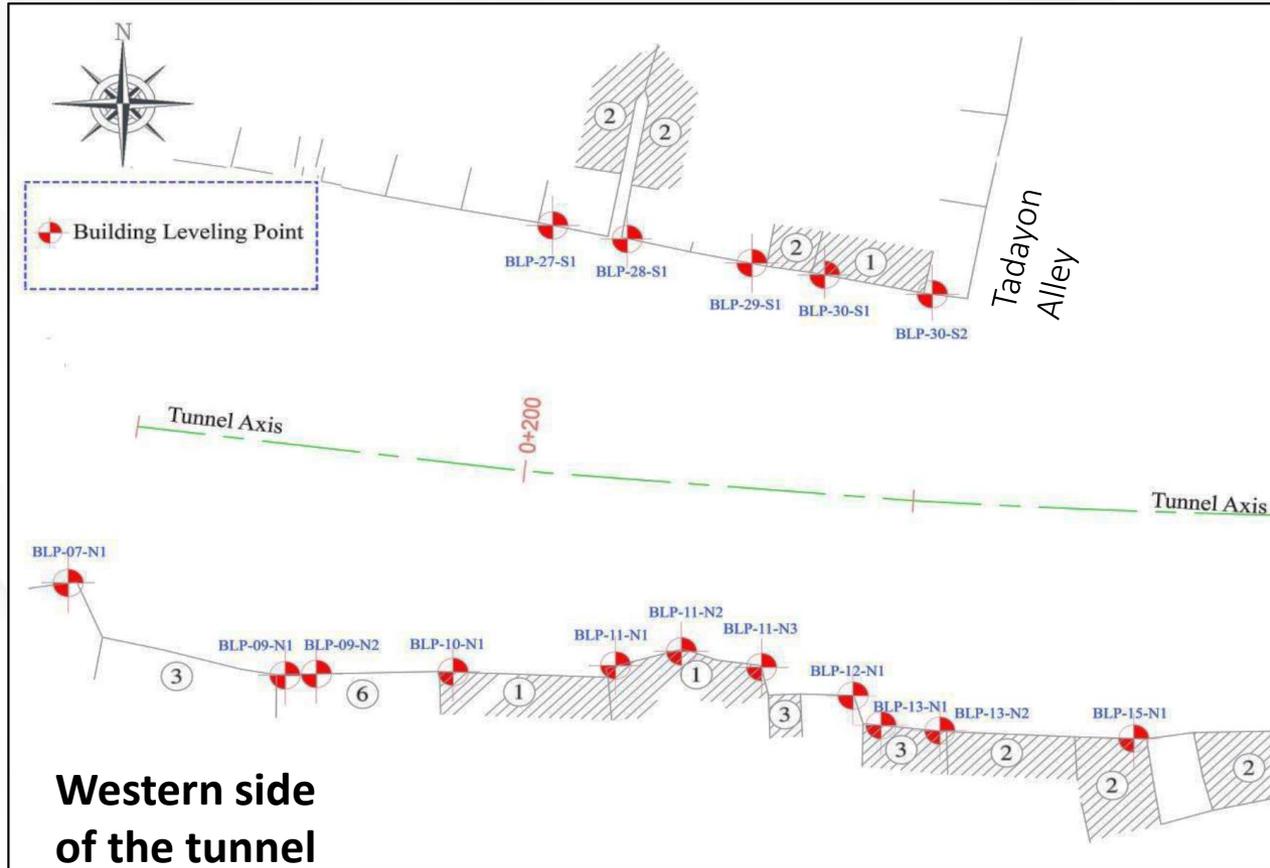


### Limitations for this project including:

- Maintaining the transit traffic of national railway and metro lines during operation
- Observing geometric design standards
- Obtaining the consent of the railway and metro authorities to cross the railway area and observing the relevant restrictions
- Maintaining the safety and security of the railway and metro route
- Choosing reliable and efficient construction method
- Construction restrictions
- Urban view and landscape



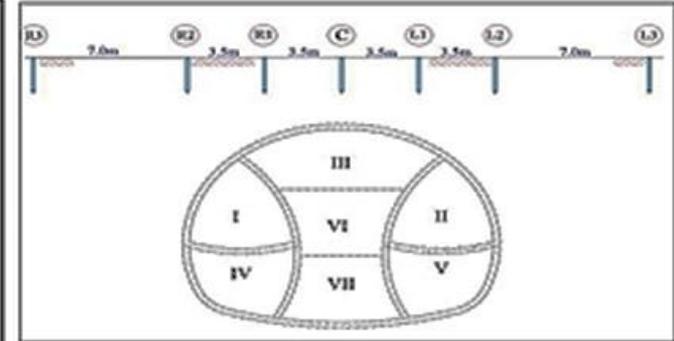
# Monitoring & Displacement Controls



➤ Buildings deformation control points



# Monitoring & Displacement Controls



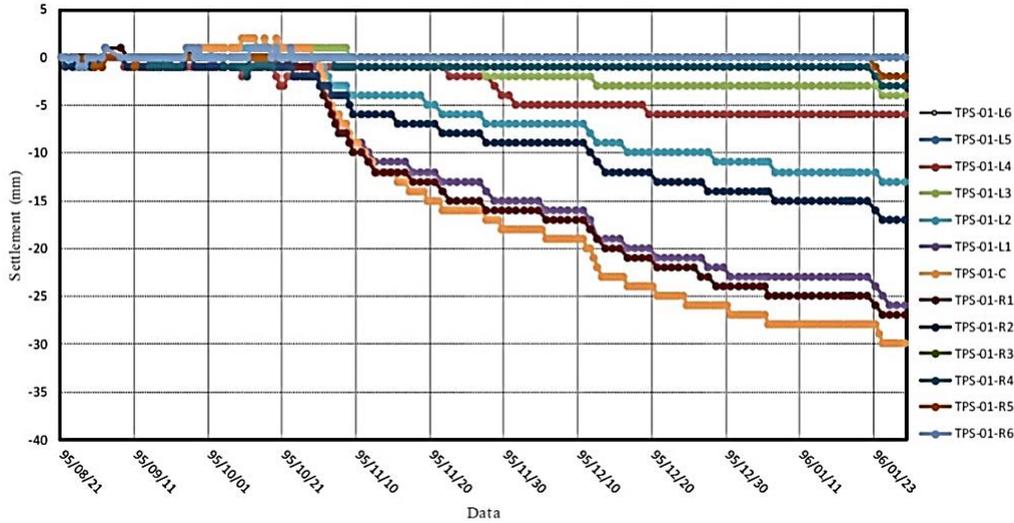
➤ Position of the surface monitoring stations in the range of the rail corridor



# Monitoring & Displacement Controls



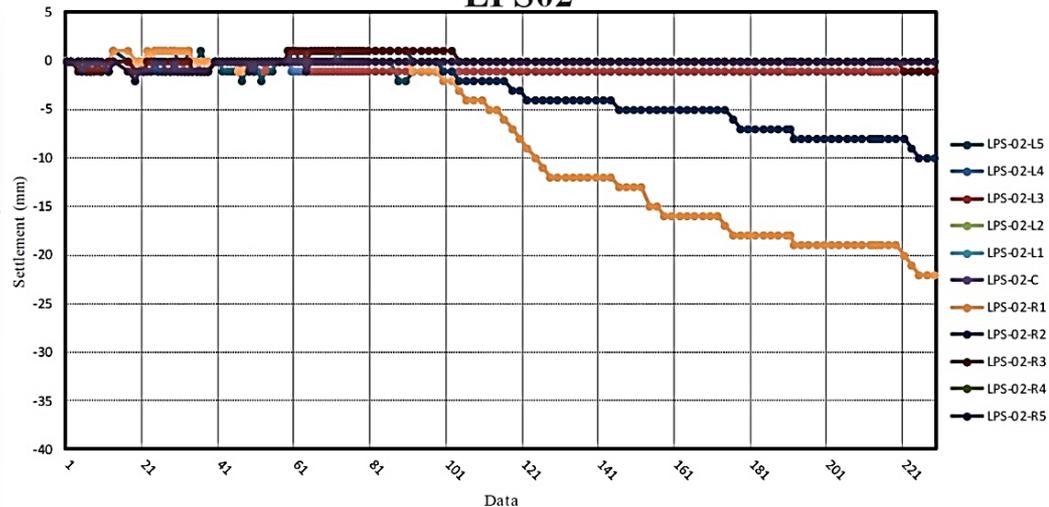
### TPS01



➤ Target prism station monitoring results (TPS01, adjacent to the railway)

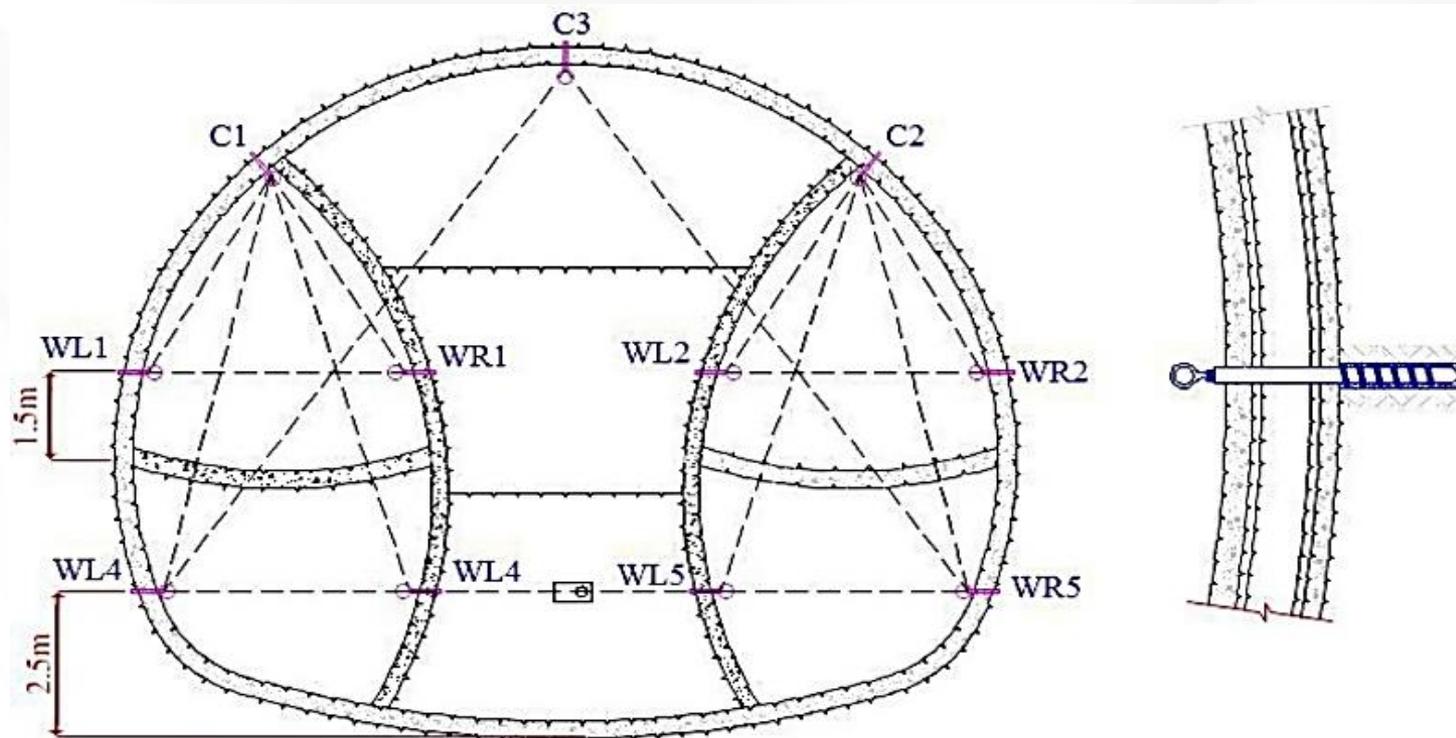
➤ Leveling point station results (LPS02, location of minimum over-burden)

### LPS02





## Monitoring & Displacement Controls



- The location of the installation of convergence pins in the walls and the tunnel roof



Some of the project management aspects that have been highlighted in this project are:



I. Existing risks forecasting, analysis and evaluation, and their response plan and overall risk management, due to the sensitivity of the railways being exploited to the extent of meeting and the possibility of leaving the train wagon from the line and causing human disaster.



II. Stakeholder management due to some key project stakeholders like Tehran Metro Company and the National Railways Company.



III. Managing Changes in the Project (Change Mgmt.) due to the possibility of changing the design and design hypothesis and the necessity of a case-by-case change in design during execution, due to the continuous receipt of the instrumentation results and the implementation of these changes in the continuation of the operation and in the shortest possible time.



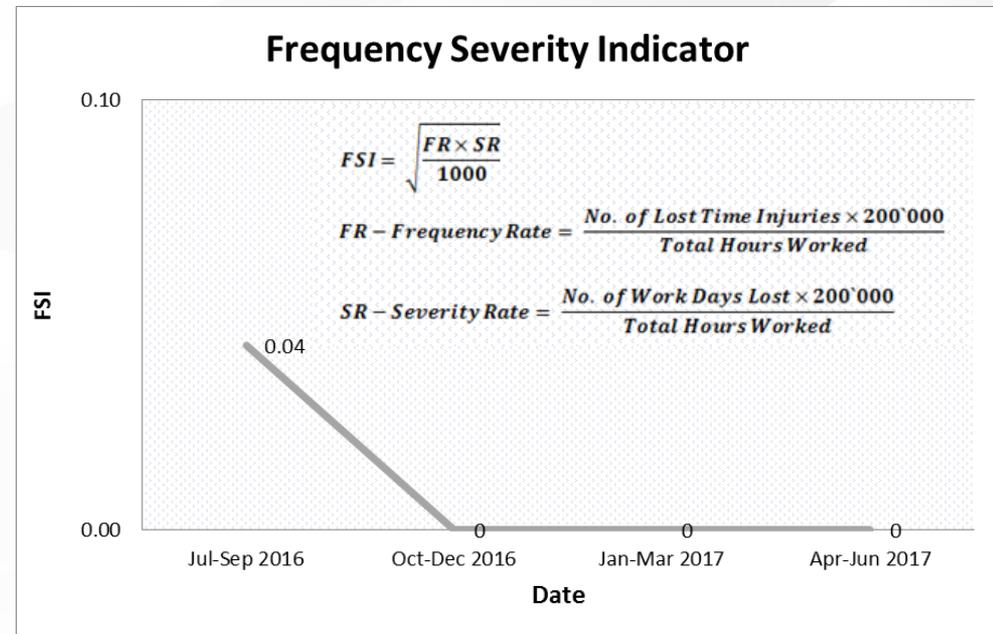
IV. Communication management to update project information and to provide and distribute this information to project stakeholders in accordance with the plans.

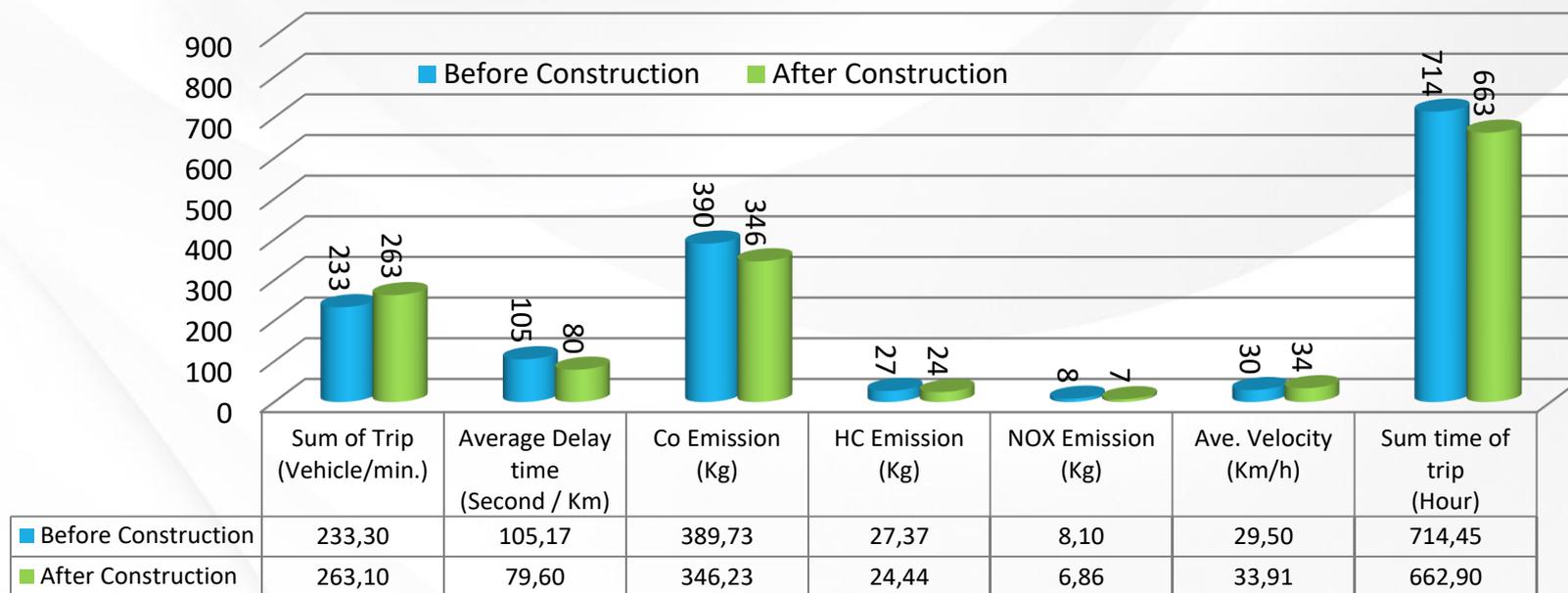


V. Integration management due to the necessity of continuation of the study and implementation processes, taking into account the latest changes and unified implementation of changes in the projected sectors.



- Due to the project's challenging conditions, despite some unidentified risks and some problems with the operation of the project, the project was put into operation in due time.
- The strict observance of the principles of safety in accordance with the standards, in all project activities and without any incident leading to human death or significant unforeseen financial consequences for the employer.
- Regarding the value added of this project, effective and efficient decision-making caused the most benefit compared to the the project cost.





Variation of traffic and environmental index chart due to project construction

- Due to the documentation of the project and lessons learnt and presentation of the experiences in the form of a report, specialized papers and seminars, a suitable model for other similar projects was provided.



## Conclusion



- In order to maintain the operation of the railways and reduce the risks, there was no possibility of stopping during the construction, and it would be necessary, with planning in different scenarios, to get prepared for design changes commensurate with the ground's response to excavation and logistical support. This was done to an acceptable level.
- Considering the design and construction limitations of this project such as very low overburden, eventually the construction of the underground section were carried out using a hybrid pre-consolidation system including the implementation of leading beams (micro tunnel) and fore-poling with an optimum cost and acceptable ground surface settlement.
- Construction of this project has reduced the East-West traffic load on one of the important highways (Be'sat) in Tehran and re-established the cultural and social link between two residential areas.
- The client's satisfaction was obtained in three main parts: Safety, Quality and Completion time of project.

23/23



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Thanks for your attention!

