Tunnelling in Urban Area by Slurry Type TBM
(Railway Bosphorus Tube Crossing Tunnels and Stations)

TUNNELLING IN URBAN AREA
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TRAINING MATERIAL PREPARED BY

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STA (Shield Tunneling Association of Japan)

was established in 1999

is joined by 100 companies
  (leading Japanese general contractors, TBM and lining segment manufacturers)

is registered 14 reliable, experienced and state-of-the-art shield tunneling technologies

is one of the prime sponsors for ITA

Tunnelling in Urban Area by Slurry Type TBM
Introduction

Tunnelling in Urban Area by Slurry Type TBM

Turkey

Istanbul

Tunnelling in Urban Area by Slurry Type TBM
Introduction

Tunnelling in Urban Area by Slurry Type TBM
Tunnelling in Urban Area by Slurry Type TBM
The reason for TBM selection

Conditions of Performance 1: In urban area
(Under the residential street or the historical building)

Asian Side Portal Area

Tunnelling in Urban Area by Slurry Type TBM
The reason for TBM selection

Conditions of Performance 2: High groundwater pressure
(Max 8.5Mpa)

Tunnelling in Urban Area by Slurry Type TBM
The reason for TBM selection

Conditions of Performance 3: Rapid construction

Total tunnel length
Asian side;
About 4.2km (14.0 months)

European Side;
About 3.6km (9.5 months)

Average 345m/month
(15m/day)
(Main excavation)

Tunnelling in Urban Area by Slurry Type TBM
The reason for TBM selection

Slurry Type TBM

Tunnelling in Urban Area by Slurry Type TBM
MECHANIZED TUNNEL CONSTRUCTION

Mechanization 1: Slurry Transportation System

Tunnelling in Urban Area by Slurry Type TBM
Mechanization: Slurry Transportation System

Central Monitoring Panel

Automatic Control (AC) System
To control the slurry pressure, amount of feeding and discharging slurry, pumps and valves are controlled by AC System.

The data necessary for TBM operation can be monitored visually and the record also can be taken.

Tunnelling in Urban Area by Slurry Type TBM
MECHANIZED TUNNEL CONSTRUCTION

1. Mechanization 1: Slurry Transportation System
   - Slurry Discharging Pump
   - Valve Set
   - Pipe Extension Equipment

Tunnelling in Urban Area by Slurry Type TBM
Mechanization

2 Backfill Grouting System

Backfill grouting shall be fed into the annular void without delay from TBM excavation speed. Backfill Grouting System control this operation automatically.

![Diagram of TBM and Backfill Grouting System]
MECHANIZED TUNNEL CONSTRUCTION

Mechanization 2 Backfill Grouting System

Automatic Mixing Plant

Injection Unit

Injection Control Panel

Injection Work

Tunnelling in Urban Area by Slurry Type TBM
During excavation, the tail seal grease shall be injected from TBM Skin Plate by automatic injection system.
MECHANIZED TUNNEL CONSTRUCTION

Mechanization

3 Tail seal grease injection

Automatic Grease Injection Unit

Tunnelling in Urban Area by Slurry Type TBM
MECHANIZED TUNNEL CONSTRUCTION

Mechanization

Automatic Survey System

ROBOTEC SYSTEM DIAGRAM
(Tunnel Guidance System)

Tunnelling in Urban Area by Slurry Type TBM
MECHANIZED TUNNEL CONSTRUCTION

1. Mechanization
2. Automatic Survey System
   In parallel with usual transit survey system, automatic survey system is applied.
   Furthermore, high-precision gyroscope is also applied to raise the precision of surveying.
CONNECTION WITH IMMERSED TUNNEL UNDER BOSPHORUS

TBM machine steel shell

Reinforced concrete lining segments

Immersed tunnel

Steel end shell

Seismic joint

Steel sleeve

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CONNECTION WITH IMMERSED TUNNEL UNDER BOSPHORUS

Mechanical Packing

Sleeve pipe
Tunnelling in Urban Area by Slurry Type TBM

CONNECTION WITH IMMERSED TUNNEL UNDER BOSPHORUS

I. Antifreeze solution
II. Shield machine
III. Warm water
IV. Tube pressure: P

Tunnelling in Urban Area by Slurry Type TBM
CONNECTION WITH IMMERSED TUNNEL UNDER BOSPHORUS

Frozen LW material

Thawed LW material

Tunnelling in Urban Area by Slurry Type TBM
Tunnelling in Urban Area by Slurry Type TBM

Connection with Immersed Tunnel Under Bosphorus

Skin Plate of TBM

Skin Plate of Sleeve

Water Pressure

Tunnelling in Urban Area by Slurry Type TBM
In Urban Area, there are many people lives and many infrastructures exist above and underground. Requirements for tunnelling method in urban area are High reliability from the point of view of Safety and Environment. Method which enable to speedy construction. To fulfil these requirements, mechanized and automated TBM method is desirable. TBM method will be developed its mechanized system and automated system continuously and the reliability of this method also be raised in the future. But important thing is that, even the automated system is developed and reliability is raised, without experienced expert who can evaluate the data and can make correct judgement, tunnelling work can never proceed with successfully.
Thank you for your kind attention

Shield Tunneling Association of Japan